30-28656

B & B PERFORATORS

RADIATION SAFETY TRAINING MANUAL
AND
OPERATING AND EMERGENCY PROCEDURES MANUAL

9507240341 950625
REG4 LIC30
49-23177-01 PDR

To: U.S. Nuclear Regulatory Commission

Attn: Material Licensing

460611

RECEIVED
APR 26 1985

B & B PERFORATORS

NRC

RADIATION SAFETY TRAINING MANUAL

AND

OPERATING & EMERGENCY PROCEDURES MANUAL

Preapred By:

Keith E. Moon, Consultant
Support Consultants & Assoc., Inc.
Route 2, Box 254
De Leon, Texas 76444

(817) 893-2088

April 1985

X60611

B & B PERFORATORS

RADIATION SAFETY TRAINING MANUAL

OPENING STATEMENT:

It is the objective of this training program to train and qualify well logging personnel in the proper use and handling of radioactive materials, to reduce hazard to other personnel at job sites, as well as to take a leadership role in promoting good health physics practices in order to keep exposure to radioactive materials as low as is reasonably achievable.

This manual gives basic fundamentals of radiation safety and will be on file for our use in acquainting new employees with the radiation hazard and for review. The training for qualification as a radiation handler will be a course taught by a State or Federally approved instructor. We will either have the instructor teach his course for our employees only, or will send our employee(s) to a school given by the instructor. This training will consist of no less than 16 hours of classroom instruction. The individual must pass the instructor's test with a minimum grade of 70. A certificate will be issued to each individual who successfully completes the training. In lieu of this training, an individual may present proof (certificate and/or test) that he has received equivalent radiation safety training in a course approved by the State or Federal Agency for control of radiation.

In addition to the Radiation Safety Course described above, each individual will read and receive instruction in the rules and regulations appropriate to our radioactive material license, and our Operating & Emergency Procedures Manual. The individual will receive on-the-job training under the personal supervision of a logging supervisor, in the use of sources of radiation and/or tracer materials, related handling tools, and radiation survey instruments which will be used in his work assignment. This training under supervision will be at least 8 hours actual handling time and 90 days on-the-job. If this training was received under another company's employ, we will obtain a signed resume of experience from the individual.

After the individual has successfully completed and demonstrated his understanding and competence in the areas above described, the Radiation Safety Officer, under the authority of the license, will designate the individual as a radiation handler. Records to support each individual's qualifications as a radiation handler will be maintained in the radiation training files.

The Radiation Safety Officer will review the information in this training manual and the Operating and Emergency Procedures manual with each new employee (including ancillary employees), and will review the information annually therafter with the employees to make them aware of the radiation hazard associated with our operations.

WHENEVER THIS MANUAL REFERENCES THE STATE OR FEDERAL REGULATORY AGENCY, IT IS TO BE UNDERSTOOD THAT FOR OPERATIONS IN THIS STATE THE AGENCY REFERENCED IS:

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV - OFFICE OF INSPECTION & ENFORCEMENT
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TEXAS 76012

TELEPHONE: (817) 860-8100

WHENEVER REFERENCE IS MADE TO THE RADIATION SAFETY OFFICER, IT IS ONE AND THE SAME AS THE RADIATION PROTECTION OFFICER.

TABLE OF CONTENTS

RADIATION SAFETY TRAINING MANUAL

I. FUNDAMENTAL CONCEPTS OF RADIOACTIVITY

A. Radioactivity: An element is said to be radioactive if it can spontaneously decay or be transformed into another element. This transformation is always accompanied by emission of nuclear radiation. The same element can occur as either radioactive or stable. These variations of the same element are called isotopes. Isotopes are defined as atoms of the same element having the same atomic numbers (Z numbers) but different mass numbers (A numbers). That is, the same number of protons, but a different number of neutrons. Therefore Pb-206, Pb-207, and Pb-208 are all isotopes of the same chemical properties whether they are radioactive or stable.

B. Characteristic Particles: The spontaneous radiation emitted by the radioactive elements are generally: Alpha, Beta and Gamma. Other radiation such as X-ray and Neutron must be induced and will be considered briefly.

1. Alpha Particles have a mass equal to that of the helium nucleus and are shot out with a velocity about one-tenth that of light, and have a positive charge of 2. They possess great ionizing power but relatively little penetrating power --- only a few centimeters in air at atmospheric pressure. Alpha particles can be shielded by paper.

2. Beta Particles consist of negatively charged particles moving with varying speeds. The penetrating power of the beta particle depends upon the speed of the particle. Those which move most rapidly possess the greatest penetrating power. Generally, 2 cm of aluminum stops all beta particles.

3. Gamma Rays are electromagnetic radiations originating from a radioactive isotopic elemental transition. They have no charge but possess great penetrating power. They present special health problems because of their deep penetration and high energy disposition. Dense materials are required to effectively shield gamma radiaton.

4. Neutrons are elementary nuclear particles with a mass approximately the same as that of a hydrogen atom and electrically neutral; its mass is 1.008982 atomic mass units. Neutrons are easily shielded with paraffin or hydrogen containing materials.

5. X-rays are similar to gamma rays in that both are electromagnetic radiation, however, they differ in their origin. When the nucleus of a radioactive atom emits an alpha or beta particle, the daughter nucleus frequently is left in a high energy or excited state and the excess energy is emitted as gamma radiation to bring the nucleus to a more stable condition. Thus, gamma radiation originates in the nucleus of an atom. X-rays, are produced when any stream of fast-moving (high energy) electrons is slowed down upon striking a suitable target.

460611

C. Detection of Radiation:

1. Radiation Measurement Devices - Used to measure radiation intensity. These Survey Meters indicate millirems per hour (mr/hr), and can be made to produce sound and light as well as deflect a needle on a scale.

   a. Ionization Counter - An ionization chamber in which a delimited beam of radiation passes between the electrodes without striking them or other internal parts of the equipment. The electric field is maintained perpendicular to the electrodes in the collecting region; as a result, the ionized volume can be accurately determined from the dimensions of the collecting electrode and the limiting diaphragm. Not suitable for measuring low intensity radiation.

   b. Geiger Mueller Detectors (Geiger Counters) - Lightweight, portable battery operated rate meters sensitive to gamma and medium energy beta radiation, and used for low intensity measurements. Contains a gas amplification tube and electronic amplified circuits. Geiger tubes use high voltages and low pressures to gain gas amplifications within the ionization chamber, and each particle or proton entering the chamber produces an avalanche of ions.

   c. Scintillation Detectors - Uses crystalline solids or organic liquids which absorb energy from radiation and emit a pulse of light. When light falls on the photomultiplier tube, electrons are released. Each electron will in turn release several other electrons. This process is continued through several stages with the electrons finally collected at the end of the photomultiplier tube. This can be seen as a voltage pulse and the instrument counts the pulse rate. These detectors have a high sensitivity and can measure extremely low level radiation, and have a higher efficiency than gas flow detectors.

2. Dosimetry Devices - Used to measure total dose.

   a. Pocket Dosimeters - The direct reading Pocket Dosimeter reads instantaneously the total accumulated dosage. The dosimeter is designed for the detection and measurement of X- and gamma radiation only. Pocket dosimeters should be worn by the person handling radioactive materials if the radiation dose exceeds 20 mr/hr at one meter.

   b. Film Badge - A small, light-weight metal or plastic badge which holds a slide-in film packet and is worn by personnel. The use of ultrasensitive films and exclusive evaluation techniques make it possible to provide accurate evaluation of even low doses. X-, gamma, and beta radiation can be detected by this means. The developed film provides a permanent legal record of exposure.

   c. Thermoluminescent Dosimeters (TLD) - A badge worn by personnel which contains a solid state device used for detection of gamma, beta, and slow neutrons. TLD badges have advantages over film badges since they are relatively insensitive to environmental effects such as heat, light and moisture. In addition, the usable range of exposure for TLD's extends into the kiloroentgen region.

460611

D. Measurement of Activity:

1. Curie - That quantity of a radioactive nuclide disintegrating at the rate of 3.700×10^{10} (37 billion) atoms per second. Abbreviation: Ci

   a. Millicurie: One thousandth of a curie (3.7×10^{7} disintegrations per second). Abbreviation: mCi

   b. Microcurie: One millionth of a curie (3.7×10^{4} disintegrations per second). Abbreviation: uCi

   c. Picocurie: One millionth of a microcurie (3.7×10^{-2} disintegrations per second or 2.22 disintegrations per minute). Abbreviation: pCi

2. Roentgen - An exposure dose of X- or gamma radiation such that the associated corpuscular emission per 0.001293 grams of air produces, in air, ions carrying 1 electrostatic unit of quantity of electricity of either sign.

3. Rad - The unit of absorbed dose, which is 100 ergs/gram in any medium. The rad is a measure of the energy imparted to matter (i.e., retained by matter) by ionizing radiation per unit mass of irradiated material at the place of interest.

4. RBE (Relative Biological Effectiveness) - The RBE is a factor which is used to compare the biological effectiveness of absorbed radiation doses(rads) due to different types of ionizing radiation. More specifically, it is the ratio of an absorbed dose of X-rays or gamma rays to the absorbed dose of a certain particular radiation required to produce an identical biological effect in a particular experimental organism or tissue. This ratio is sometimes called the Relative Biological Efficiency Factor.

5. Rem (Roentgen Equivalent Man) - The rem is the unit used to express human biological doses as a result of exposure to one or many types of ionizing radiation. The dose in rems is equal to the absorbed dose in rads times the RBE factor of the type of radiation being absorbed. Thus, the rem is the unit of RBE dose. Millirem is one thousandth of a rem. Abbreviation: mr -- mr/hr expresses the dose in millirems per hour.

E. Technical Aspects of Isotopes:

1. Half-Life - All radioactive isotopes have a special property associated with them known as half-life. Half-life is the time required for the activity of a given radioactive element to decrease to half of its initial value due to radioactive decay. The biological half-life is the time required for the amount of a specified element which has entered the body (or a particular organ) to be decreased to half of its initial value as a result of natural, biological elimination processes. The effective half-life of a given isotope is the time in which the quantity in the body will decrease to half as a result of both radioactive decay and biological elimination.

Examples:

Radioactive Element	Half-Life
Cobalt 60	5.26 years
Iodine 131	8.05 days
Cesium 137	30.0 years
Iridium 192	74.4 days
Radium 226	1,602.0 years
Americium 241	458.0 years

2. Energy of Emission - All isotopes have definite amounts of energy associated with each particle being emitted. These energies are characteristic of the isotope.

3. Effect of Distance - Generally speaking, the greater the distance from the source of radiation, the less the dose received by personnel. The intensity of radiation is diminished by an inverse square relationship with distance. A source measuring an intensity of 100 mr at a distance of one foot would measure 100 mr/5^2 at a distance of five feet; in other words, a radiation dose of 4 mr at the five foot distance.

4. Shielding of Various Materials - A shield can be any material or obstruction which absorbs radiation and, thus, tends to protect personnel or materials from the effects of nuclear radioactivity. Alpha particles, for example, can be shielded with a piece of paper. Beta particles can generally be absorbed through 2 cm of aluminum. Gamma rays, however, are the most penetrating, and dense shielding materials must be employed to reduce radiation.

F. Glossary and Terminology:

1. Isotopes - Forms of the same element having identical chemical properties but differing in their atomic masses (due to different numbers of neutrons in their respective nuclei) and in their nuclear properties (e.g. radioactivity, fission, etc.).

2. Radicactive Material - Any material (solid, liquid, or gas) which emits radiation spontaneously.

3. Sealed Source - Radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

4. Maximum Permissible Concentration (MPC) - The highest currently acceptable concentration of radioactive substances (usually expressed as microcuries per cubic centimeter (uc/cc) in air, water, or food to which an individual may be exposed throughout a stated period of time without expectation of injury.

5. Maximum Permissible Dose (MPD) - That dose of ionizing radiation that a person may receive in his lifetime without producing any appreciable bodily injury. The formula for determining the presently accepted MPD (referred to as "bank account") is (N-18) x 5 rems. N is the individual's age (greater than 18).

6. Radiation Area - Any area accessible to individuals in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of five millirems, or in any five consecutive days a dose in excess of one hundred millirems.

7. Restricted Area - Any area to which access is controlled by the licensee for purposes of protection of individuals from exposure to radiation. (Generally, any area within which a survey meter reading is 2 mr or above.)

8. Radation Safety Officer (Radiation Protection Officer) - Person who has a knowledge of and the responsibility to apply appropriate radiation protection regulations, standards, and practices. Each licensee has a designated R.S.O. or R.P.O. who oversees the company's radiation safety program.

9. Agreement State - Any state with which the U.S. Nuclear Regulatory Commission has entered into an agreement allowing that state to regulate their own radiation control program.

10. Inverse Square Law - The law which states that when radiation (thermal or nuclear) from a point source is emitted uniformly in all directions, the amount received per unit area at any given distance from the source is inversely proportional to the square of that distance. (See diagram on next page.)

INVERSE SQUARE LAW:

Simply stated, the inverse square law is a general property of physics which states that if the distance from a point is doubled, then the radiation at the second point will be 1/4 of the radiation which is present per unit area at the first point.

Mathematically the inverse square law is expressed as follows:

$$\frac{Ia}{Ib} = \frac{(Db)^2}{(Da)^2}$$

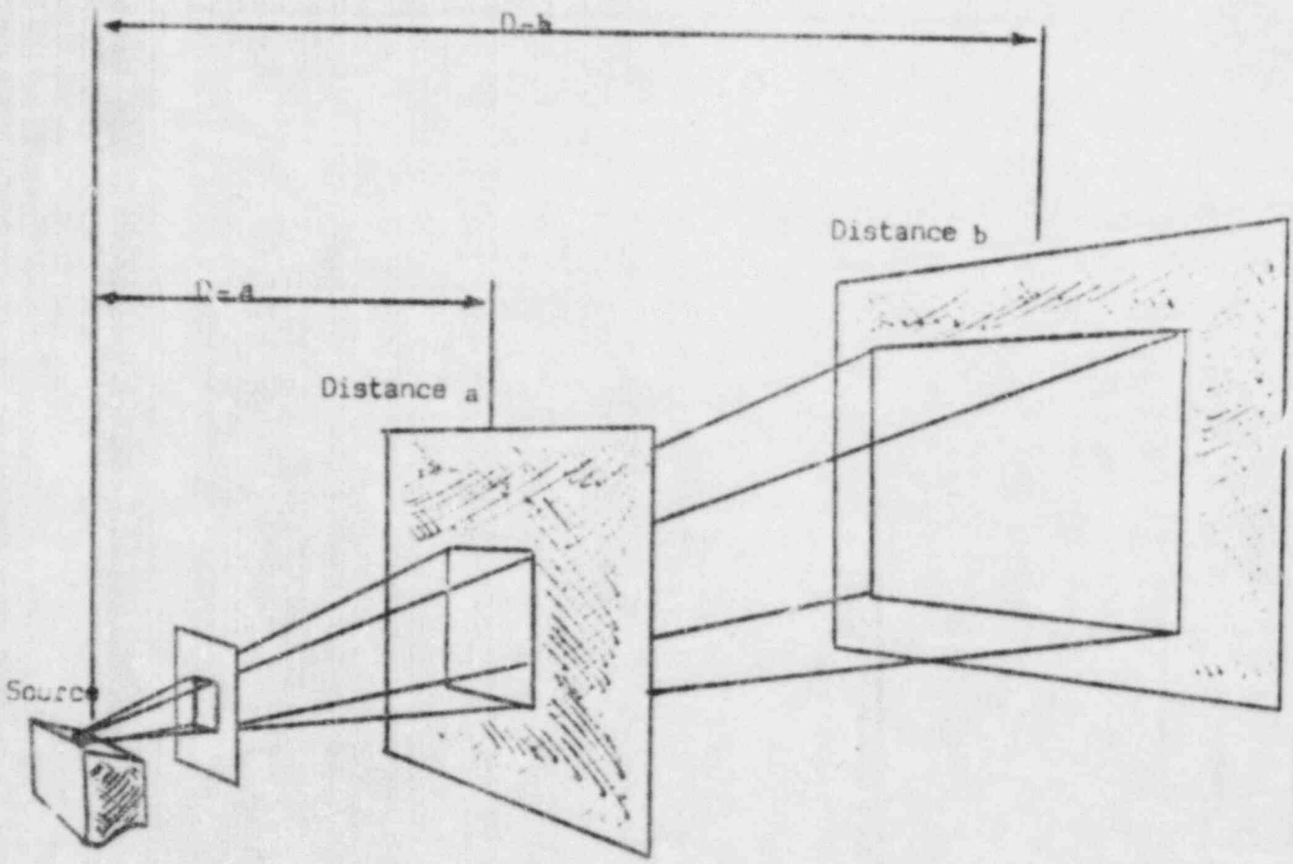


Diagram of the Inverse Square Law

II. BIOLOGICAL EFFECTS OF RADIATION

A. Characteristics of Radiation:

1. Ionization in Tissues - Radiation in tissues varies in relation to (a) the energy of the radiation, (b) the absorbed dose, (c) the time span over which the dose was received, (d) the amount of body area irradiated, plus (e) other factors not so well defined. Ionization of the atoms which make up the chemical constituents of the tissue cells, as the result of interactions with the incident radiation, is probably the basic cause of injury. Irradiation within the cell can result in (1) death of the cell, (2) complete destruction of the cell's ability to reproduce, (3) partial, incomplete, or faulty function (as of glandular cells) as well as, (4) production of genetic mutations.

2. Radiosensitivity of Tissue - Various types of tissue respond quite differently to a given kind and dose of radiation. Generally speaking, the following may be accepted as a list of common cells and/or tissues in the order of decreasing radiosensitivity:

   a. Lymph tissue (cells of the body fluid)

   b. White blood cells and immature red blood cells in the bone marrow

   c. Cells lining the gastro-intestinal tract

   d. Cells of the reproductive organs

   e. Skin

   f. Blood vessels and body cavity lining

   g. Tissue of the liver and adrenal glands

   h. Other tissues, including bone, muscle, and nerves

3. Time Factor vs. Total Dose - The biological effect of radiation depends not only on the total amount absorbed (dose), but also on the rate of absorption (dose rate). For example, 600 r would probably be fatal to a man if it were absorbed by the whole body within a period of one day; but would probably have no noticeable effect if absorbed over a period of 30 years because the body tissue is able to recover when the dose rate is low. Effects of radiation which appear within approximately a month are termed acute effects. This includes the immediate (0 to 48 hours) and the delayed (1 to 5 weeks) effects. Chronic effects would include those which result in persistent changes (radiation dermatitis), vascular or atrophic changes, and long term effects (appearing after one year -- tumor induction, cataract formation).

B. Radiation Doses to be Considered

1. Acute Effects of Whole-Body Penetrating Ionizing Radiation on Human Beings:

Dose in Less Than One Week (Rems)	Effects
0 - 150	No acute effects other than blood changes. May be a serious long-time hazard.
150 - 250	Nausea and vomiting within 24 hours. Minimal incapacitation after 2 days.
250 - 350	Nausea and vomiting in under 4 hours. Some mortality will occur in 2 to 4 weeks. Symptom free period 48 hours to 2 weeks.
350 - 600	Nausea and vomiting likely before 2 hours. Mortality probably in 2 to 4 weeks. Incapacitation prolonged.
Greater than 600	Nausea and vomiting almost immediately. Death in 1 to 2 weeks.

2. Tolerance Dosages

a. 100 Millirems/week for whole body or

b.

Area of Body	Rems/Calendar Quarter
Whole body; head and trunk; active blood forming organs; lenses of eyes; or gonads	1.25
Hands and forearms; feet and ankles	18.75
Skin of whole body	7.5

C. Safety Precautions: The most important safety considerations for protection from radiation are time, distance and shielding.

1. Safety Through Time - Exposure to an individual may be reduced by controlling the amount of time spent handling radioactive materials. If exposure attains an unsafe limit, personnel should be rotated. "Stay time" is the period during which personnel are allowed to remain in a radiation and/or contaminated area before accumulating their permissable dose.

2. Safety Through Distance - Distance can be an effective safety measure (reference Inverse Square Law). Safe distances should be known for the amounts of radioactive material being handled.

   Examples of exposure rates at various distances from a 100 mCi source:

Radioactive Material	mr 3 feet	mr 6 feet	mr 9 feet
Iridium 192	61	15.25	6.8
Iodine 131	25	6.25	2.8

3. Safety Through Shielding - Certain materials are effective shields against radiation. Lead is the most common shield material. The half-value layer is the thickness of shielding material necessary to reduce the radiation intensity to one-half its original intensity.

   Following are half-value layers for some common shielding materials:

Radioactive Material	Lead	Steel	Concrete
Cobalt 60	0.49"	0.87"	5.0"
Cesium 137	0.25"	0.68"	2.1"
Iridium 192	0.19"	0.5"	1.9"

460611

III. HEALTH PHYSICS REGARDING USE OF RADIOACTIVE MATERIALS (WELL LOGGERS)

A. Monitoring Job Site

1. Using a low level survey meter, and before work initiation, monitor the area. Record the observations on a sketch of the area.

2. Certify the area clean before commencing the job.

B. Handling Equipment - The following items shall be worn at times when handling the radioactive material while health physics problems are present:

1. Disposable gloves will always be worn in handling radioactive materials, thus, preventing the possibility of contamination to the person who is actually handling the radioactive material.

2. Face masks shall be worn at all times when a gaseous radioactive material is being used in a field study. The face mask shall be a type approved by the National Bureau of Mines and should contain an excellent organic filter agent.

3. In some radioactive material applications, it is necessary to wear protective clothing and/or use handling tongs.

C. Pocket Dosimeters can be worn by personnel who are handling the radioactive materials. If, however, personnel also carry personal film badges, then the option is present as to whether the pocket dosimeter be worn. The advantage to the pocket dosimeter is direct reading, and if the radiation level is not excessive (generally 1 to 10 mCi of Iodine-131 will be handled per injection), then it should be the option of the field safety officer as to whether pocket dosimeters be worn.

D. TLD Badges - It will be mandatory for all personnel working in the restricted area (an area greater than 2 mr/hr) to wear a TLD badge.

E. Tracer Packaging - All packages received from the supplier containing radioactive materials shall be monitored on receipt and prior to transporting to job site. The dosage limits shall comply to the D.O.T. regulations (49 CFR), which stipulate a maximum of 200 mr/hr at surface of a shipping container and a maximum of 10 mr/hr at a distance of one meter from the surface of the container. Packages received from the supplier generally bear a diamond shaped Yellow III label.

F. Field Equipment Check List: The specific application may require additional radiation detection equipment, but generally, the field equipment will consist of the following items:

TLD badges
Low level survey meter*
Fire extinguisher
First aid kit
Absorbent napkins
Sponges
Large and small polyethylene storage bags
Masking and plastic electrical tape
Plastic wash bottles
Plastic or rubber gloves (disposable)
Labels for the return of radioactive waste
Concentrated wash solution
Goggles

* Survey meters shall be currently calibrated and operable. Survey meters must be calibrated at 6 months intervals.

G. Operating Procedure:

1. Pre-job knowledge and planning -- the Radiological Safety Supervisor must know:

   a. Types of radiation involved.

   b. Intensity of radiation.

   c. Relative hazard of each type of radiation.

   d. What the "stay time" (maximum allowable exposure time) is.

   e. What the possible contamination problems are.

   f. Any internal contamination problems.

   g. What industrial nuisance removable contamination will create.

   h. What controls must be dictated to protect personnel.

   i. Plan methods for controlling access to mixing and injection areas.

2. Specific Procedures will vary with the individual job applications. In general, the following procedures should be followed:

   a. Plan the job in advance.

   b. Monitor the area and measure the background radiation level.

   c. Optimum mixing location should be selected. Radioactive material should be mixed with injection fluid as close to well head as possible.

   d. Define the area which is prohibited to unauthorized personnel. (2 mr/hr is the maximum allowable radiation to people not wearing film badges.)

   e. Mix radioactive material with injection fluid with special consideration given to splashing, wind conditions and any other outside influence which could interfere with the safe handling of the material.

f. Plastic or rubber gloves should be worn at all times while handli g radioactive materials. If wind velocity is sufficient to cause blowing, goggles and respirator should be used.

g. Exposure time should be controlled. If exposure approaches the maximum permissible limit, personnel should be rotated.

h. Allow no eating, smoking, or drinking in the restricted area.

i. Following the completion of the operation, the entire area should be monitored.

j. Radioactive Contamination Inspection Date Sheet should be filled out and given to customer.

H. Emergency Procedures: Emergencies vary greatly in their respective hazards. Sometimes these emergencies are in the form of spills, fires, or explosions which, consequently, result in the spread of radioactive contamination. Emergency procedures contained in the National Bureau of Standards, Handbook No. 48, are given here as a guide. It must be recognized that these procedures are general and any specific emergency would certainly involve additional procedures not specifically covered in this outline.

1. Spills involving no radiation hazard to personnel:

   a. Notify all personnel in the area at once.
   b. Permit only a minimum number of personnel in the vicinity of the spill.
   c. Confine the spill immediately.
   d. Notify the Radiation Safety Officer.
   e. Decontaminate.
   f. Monitor all personnel involved in the spill and cleaning.
   g. Permit no person to resume work in the area until it has been surveyed and approved by one of the approved individual users specified on the N.R.C. and/or Agreement State Radioactive Material License.

2. Spills involving radiation hazard to personnel:

   a. Notify all personnel not involved in the spill to vacate the area at once.
   b. If the spill is liquid and the hands are protected, right the container.
   c. If the spill is on the skin, flush thoroughly.
   d. If the spill is on the clothing, discard outer or protective clothing at once.
   e. Switch off all fans. Vacate the room.
   f. Notify the Radiation Protection Officer as soon as possible.

460611

g. Take immediate steps to decontaminate personnel involved.
h. Decontaminate the area.
i. Permit no person to resume work in the area until a survey is made and approval is received from the R.S.O.
j. Prepare a complete history of the accident, and give details in the Emergency Procedures Report.

3. Injuries to personnel involving radiation hazards:

a. Wash minor wounds immediately under running water while spreading the edges of the gash.
b. Call a physician, preferably one who is qualified to treat radiation injuries.
c. Permit no person involved in a radiation injury to return to work without the approval of the attending physician.
d. Report all radiation accidents (wounds, over-exposure, injection, inhalation) to your supervisor.
e. Prepare a complete history of the accident and give the details in the Emergency Procedures Report.

4. Vehicle wreck while transporting radioactive materials:

a. Do not leave the area unattended by qualified personnel.
b. Notify the investigating officer.
c. Notify the Radiation Safety Officer.
d. Survey the area and close off any area where the level is above 2 mr/hr.
e. Decontaminate the contaminated area (if any).
f. The R.S.O. will notify the proper Federal and State Agencies.

5. Fire and other major emergencies:

a. Notify all personnel in the area at once.
b. Attempt to put out all fires if radiation hazard is not immediately present.
c. Notify the Fire Department.
d. Notify the Radiation Safety Officer.
e. Govern the fire fighting or other emergency activities by the restrictions of the Radiation Safety Officer.
f. Following the emergency, monitor the area and determine the emergency devices necessary for safe decontamination.
g. Decontaminate.
h. Permit no person to resume work without approval of the Radiation Safety Officer.
i. Monitor all persons involved in combating the emergency.
j. Prepare a complete history of the accident and give the details in the Emergency Procedures Report.

I. Monitoring Techniques for Personnel:

1. Check hands (finger tips), shoes (soles and heels), face (nostrils) first.

2. Remove any contaminated clothing to a covered bin and continue monitoring.

3. Check hands ALWAYS before eating, drinking, or smoking. Cleanse carefully of contamination (scrub with soap and water), and check again.

J. Transportation, Storage and Disposition:

1. Transportation of Radioactive Material:

a. Radioactive materials being transported must meet the same requirements as packaging of materials.

b. When transporting radioactive materials in a passenger automobile, the materials should be carried in the trunk compartment at the furtherest point possible away from the driver or passengers.

c. When transporting radioactive materials in a truck, the materials should be carried in a D.O.T. 7-A container, at the furtherest point possible away from the driver or passengers.

d. Any vehicle transporting radioactive materials should be posted with suitable signs.

e. Radioactive materials should be packed in such a manner so that there is no danger of spilling or loss.

f. In the event of an accident while transporting radioactive materials, efforts should be made to minimize the exposure of any persons. This could include any action such as roping off the area and notifying investigation officers. The Radiation Safety Officer should be notified immediately in order that the State or Federal Agency may be contacted if necessary.

2. Storage of Radioactive Materials:

a. Radioactive materials shall be stored in a suitable shielded container and will be covered at all times with suitable lids to prevent unnecessary exposure. Only authorized personnel shall have access to the storage facility. Suitable markings will be placed at the location.

b. An additional storage unit of suitable construction will be provided for the temporary storage of empty containers (e.g. lead pigs) or contaminated objects such as tools, rags, clothing, etc. This storage unit shall remain locked at all times. Radiation warning signs will be posted. (Not applicable to pipe inspection companies.)

3. Records and Reports: The following records and reports will be made:

a. Records showing the radiation exposures of all personnel for whom monitoring is required. Film or TLD badge records must be maintained indefinitely.

b. Each Licensee shall report by telephone and telegraph to the Federal or State Agency, the theft or loss of any source of radiation immediately upon knowledge of it.

c. Each Licensee shall notify the Federal or State Agency upon an incident causing an individual to receive radiation in excess of the permissible limit.

4. Waste Disposal:

a. Disposal by release into sanitary sewage systems -- No Licensee shall discharge radioactive material into a sanitary sewage system, unless, it is readily soluble in water and does not exceed the MPC as specified in 10 C.F.R. or applicable State regulations.

b. Disposal by burial -- No Licensee shall dispose of radioactive material by burial without a permit obtained from the Federal or State authorities.

c. Disposal by incineration -- No Licensee shall dispose of radioactive material by means of incineration.

d. All radioactive waste materials will be turned over to a supplier who is licensed to receive radioactive waste, or they will be transported to a State or Federally approved waste disposal site.

e. Sealed sources of radioactive materials will be returned to the manufacturer for disposal.

5. Markings:

a. Radiation warning signs prescribed by this section shall be the standard radiation colors (magenta or purple on yellow background), with the conventional three-bladed symbol and the words "CAUTION - RADIOACTIVE MATERIALS" or "CAUTION - RADIATION AREA", whichever is applicable.

b. Use of signs -- Radiation warning signs shall be used in the following instances:

(1) Radiation areas. (Specifically, any area where the survey meter reading exceeds 2 mr/hr.)
(2) Rooms or areas where radioactive materials are stored in quantities exceeding those specified in 10 CFR or applicable State regulations.
(3) Containers in which radioactive material is stored.
(4) Vehicles transporting radioactive material labeled Yellow III.

c. Radioactive Material Labels - Each package of radioactive material (or device) which is transported must be labeled on two opposite sides with distinctive warning labels. There are three labels bearing the standard three-bladed radiation symbol which alert persons handling packages that the package may require special handling. (Ref: 49 CFR, Parts 172.436 through 172.440.) Labels are 4" x 4".

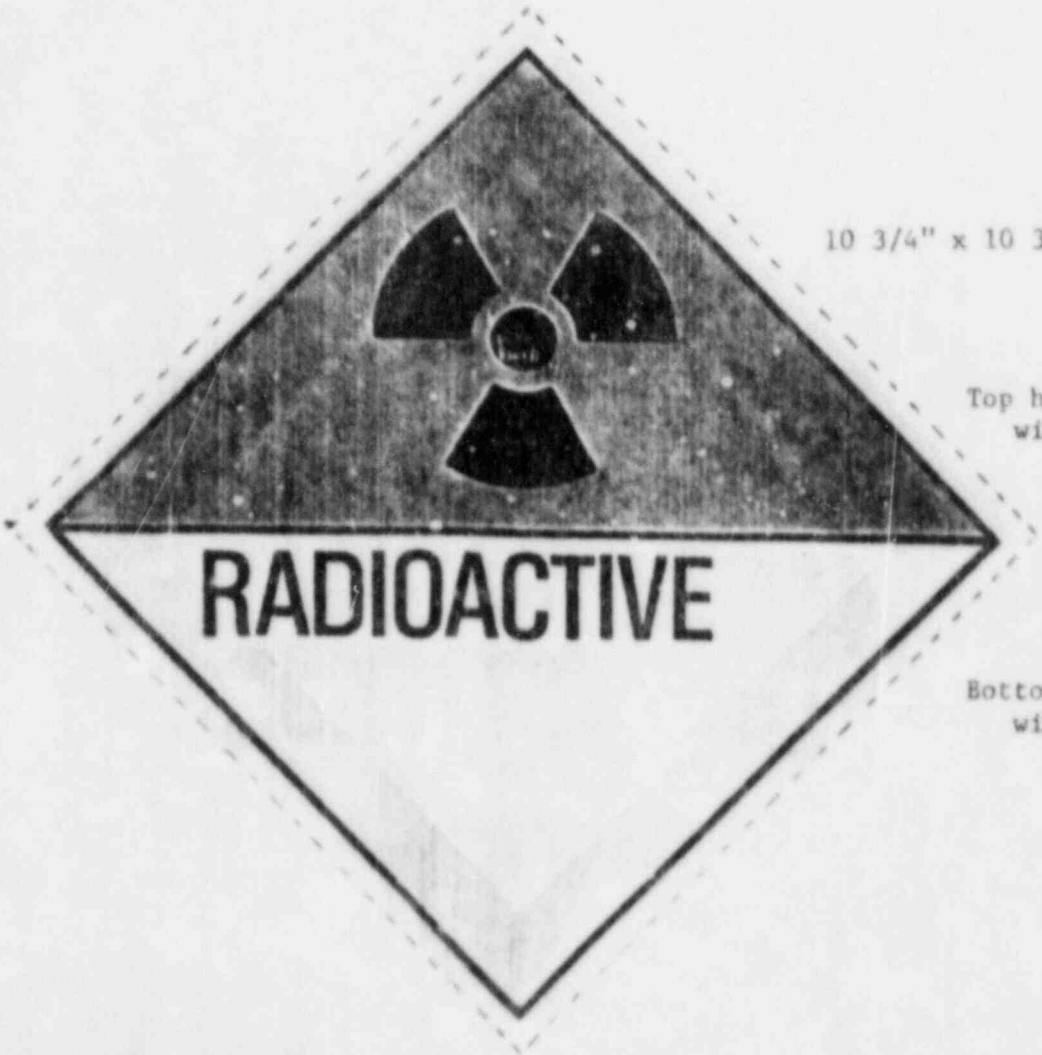
(1) If the background color of the label is all white, with one vertical bar (red) on the lower half, the radiation is minimal and nothing special is required for that package.
(2) If the background of the upper half of the label is yellow, with two vertical bars (red) in the lower half, a radiation level requiring consideration may exist at the outside of the package and the transport index must be reflected.(Survey reading below 1 mr/hr at three feet.)
(3) If the background of the upper half of the label is yellow, with three vertical bars (red) in the lower half, the transport index must be reflected and the vehicle transporting the radioactive material must be placarded, as specified in 49 CFR Part 172.556. (Survey meter reading 1 mr/hr or more, not to exceed 10 mr/hr, at 3 feet from package or device.)

RADIOACTIVE-WHITE I

RADIOACTIVE-YELLOW II

RADIOACTIVE-YELLOW III

RADIOACTIVE PLACARD



10 3/4" x 10 3/4" Placard

Top half: yellow
with black symbol

Bottom half: white
with black letters

Vehicle transporting radioactive material labeled Yellow III requires placard on each end and each side.

460611

B & B PERFORATORS

TABLE OF CONTENTS

SECTION 2: OPERATING AND EMERGENCY PROCEDURES MANUAL

REFERENCE FIGURES:

B & B PERFORATORS

SECTION 2 - OPERATING & EMERGENCY PROCEDURES MANUAL

OPENING STATEMENT:

This manual outlines procedures pertaining to the use and handling of radioactive sources. It is the intent of B & B Perforators to comply in every way possible with State and Federal regulations for control of radiation. Although our operations are such that the levels of radiation provide a low risk of exposure, we will follow procedures and practices that will maintain doses to individuals as low as is reasonably achievable.

Management and the Radiation Protection Officer will regularly review the status of B & B Perforator's safety procedures and policies and search out any discrepancies which might exist. Our health physics program will be reviewed on a regular basis and upgraded as it pertains to exposure, and new programs implemented if determined that improvement can be made.

It is the intent of B & B Perforators to minimize safety and noncompliance problems, to minimize hazards to employees, and to insure that all company personnel are committed to a safe and proficient safety program. We will make every effort to inform and train our employees in the proper use and handling of radioactive materials. We will follow to the best of our ability procedures to assure that no radiation exposure will cause harm to our personnel, our customer's personnel, or the general public.

The following pages outline our operating procedures and emergency procedures, and are supplemental to our license application.

I. MANAGEMENT RESPONSIBILITY

A. The Radiation Safety Officer (R.S.O.) is responsible for the over-all radiation procedures and training function. These duties consist of:

1. Making sure all facilities are inspected monthly to determine the contamination levels, if any.
2. Maintaining proper files for the protection of the employees and the review of regulatory agents.
3. Providing an effective and ongoing training program for all employees who handle radioactive materials.
4. To insure that all waste procedures are implemented.
5. To insure that all transportation of radioactive material is done in compliance with D.O.T. regulations (49 CFR).
6. To insure that job site surveys and vehicle surveys are completed within specified time.
7. Providing monthly checks on all radiation handlers to insure proper compliance with all State and Federal regulations.
8. Maintaining a personnel monitoring device.
9. Maintaining records to insure that no excessive exposures are received by employees (not to exceed 1.25 Rems per calendar quarter or no more than 5.0 Rems per calendar year.)
10. To insure that survey meters are calibrated every six months.
11. To insure that leak/wipe tests of sealed sources are performed every six months. (If licensed for radioactive source.)
12. The Radiation Safety Officer is committed to make every effort to comply with State and Federal regulations for control of radiation and to report any deficiency or area of non-compliance to the radiation safety committee.

B. Management Records - Master Radiation Files will be maintained at the facility by the R.S.O. Some of the records contained in these files are:

1. Radiation License Information
   (a) License and Amendments
   (b) Procedures Manual
   (c) State/Federal Rules and Regulations

2. Personnel Exposure Records
   (a) Reports from dosimetry service
   (b) Employee termination exposure report letters

3. Survey Records
   (a) Survey meter calibration certificates
   (b) Monthly facility surveys
   (c) Monthly bunker surveys
   (d) Monthly vehicle surveys
   (e) Job site surveys

4. Source Information (If licensed for radioactive source.)
   (a) Source inventory
   (b) Source utilization log
   (c) Receipts of purchase and disposal
   (d) Leak/wipe test reports
   (e) Physical inspection of source assembly, container, & tools.
5. Tracer Material Use (If licensed for I-131 and Ir-192)
   (a) RA material receiving log
   (b) Packing slip and receipt of delivery
   (c) RA material use log
   (d) RA waste disposal log
   (e) Receipt for shipment for disposal of RA material

C. Bulletin Board

1. Post - "Notice to Employees"
2. Post - Current personnel exposure report
3. Post - Notice of where license, procedures manual, and regulations can be found

D. Training of Personnel

1. No company employee will be allowed to use or supervise the use of radioactive materials until he has first:

   (a) Successfully completed a State or Federally approved radiation safety training course.
   (b) Read and received instruction in the applicable State or Federal rules and regulations.
   (c) Read and received instruction in the company's operating and emergency procedures and demonstrated an understanding thereof.
   (d) Demonstrated competence to use radioactive materials, related handling tools and radiation survey instruments which will be employed in his assignment.

2. Employees may assist in operations using radioactive materials under the direct supervision of someone qualified under section D-1, if said assistant has:

   (a) Read or received instruction in the company's operating and emergency procedures and demonstrated an understanding thereof.
   (b) Demonstrated competence to use the radioactive materials, related handling tools and radiation survey instruments which will be employed in his assignment.

3. Records of qualifications, certificates of training, etc., indicating that the above requirements have been met will be maintained in the radiation files for inspection.

4. Upon hiring, all personnel whose duties may require them to work in/around or visit a restricted area will be informed of the radiation hazards and appropriate precautions as prescribed in 10 CFR 19.12 "Instructions to Workers". A review of the hazards and appropriate precautions will be made annually thereafter, either individually or in group safety meetings.

II. RADIATION SAFETY AND MONITORING DEVICES

A. TLD Badges: (Thermoluminescent Dosimeter)

1. A TLD badge will be assigned by name and number to each employee working with radioactive materials. Under NO circumstances will an employee be permitted to use a TLD badge other than his own.

2. The Radiation Safety Officer will be responsible for the distribution of the TLD badges and the procedures governing their use. Care should be taken to prevent exposure of TLD badges to environmental conditions which involve excessive heat or moisture as such exposure will impair the ability of the badges to measure radiation dosage.

3. TLD badges will be worn attached to clothing in the trunk area of the body during all operations which involve possible exposure to radiation.

4. TLD badges will be returned to the Radiation Safety Officer, or his designated representative, at the end of the control period for the badge.

5. TLD badge reports will be kept up-to-date by the Radiation Safety Officer. These reports will become a part of each employee's personnel record by means of an individual exposure report which will be maintained on a quarterly basis by the R.S.O. Each person to whom a TLD badge is assigned will be informed of his total radiation exposure upon request or within thirty (30) days after termination.

B. Survey Meters:

1. A radiation survey meter shall be carried on each vehicle used for transportation of radioactive materials. Survey meters used shall be sensitive to gamma radiation.

2. One or more operable radiation survey meters will be kept at the base facility as a spare and for emergency use.

3. A job site survey must be made before and after each operation using radioactive materials. (Ref: Figure #6) A record of each survey will be kept in the company's survey file.

4. A calibration check shall be performed on each radiation survey meter at six months intervals and after repair. The calibration check shall consist of testing the survey meter at two points other than zero, on each scale using a radiation source of known output. The calibration will be performed by a State or Federally approved survey meter calibration service company. A written record of this calibration will be kept by the R.S.O. in the company's survey file.

5. A survey must be made and recorded for each operation using sealed radiation sources. (Ref: Figure #6)

C. Leak/wipe Tests for Sealed Sources:

1. A leak/wipe test shall be performed on each sealed radiation source at six months intervals. Leak/wipe tests will be performed by the Radiation Safety Officer or other authorized user.

2. Leak/wipe tests will be performed through the use of kits according to the accompanying instructions. The kits will be supplied by one of the following:

   Suntrac Services, Inc. (SIT-1), Webster, Texas
   G.E. Smith & Associates, Pasadena, TX (Leak TEst Kit #2)
   Nuclear Sources & Services, Inc., Houston, Texas (LT-1)
   Gulf Nuclear, Houston, Texas (LTK-1)
   Eberline Instruments, Santa Fe, New Mexico
   or Any otherState or Federally approved company providing this service.

3. After the wipe/test is performed, the kit will be checked with a survey meter prior to any shipment by U.S. mail or private carrier.

4. Leak/wipe test evaluations will be done in accordance with standard license requirements, and will provide data sensitive to 0.005 microcurie of removable contamination.

5. Results of leak/wipe tests (evaluation reports) will be retained for review by regulatory agents.

III. STORAGE FACILITIES

A. Storing and Securing

1. When not being used, the radioactive source(s) will be placed in a secure area that is properly marked with warning signs around the perimeter. This storage area will be locked at all times except when removing or returning sources. (Ref: Figure # 5)

2. Storage facilities are designed and positioned so that no person in an uncontrolled area will receive more than 2 mr in any hour or more than 100 mr in any seven (7) consecutive days.

3. Only licensed radiation handlers will be allowed to remove or replace the source(s) and they must be wearing a TLD badge.

4. Monthly storage bunker surveys will be made by the R.S.O. and kept in the survey files. (Ref: Figure # 5)

B. Vehicle Storage

1. The radioactive source will be locked in a transport container near the rear of the transport vehicle. This container will remain locked at all times except when removing or replacing sources.

2. The transport container must be an approved D.O.T. 7-A container and should be placed at the furtherest point possible away from the driver or passengers. Documentation of the container's certification as D.O.T. 7-A should be kept in the radiation files.

C. Posting Restricted Areas, Vehicles and Labelling Containers

1. Posting restricted areas and storage areas where the levels are expected to achieve 2 mr per hour will be labelled with signs stating "Caution - Radiation Area" or "Caution - Radioactive Materials." These signs will bear the radiation symbol and be magenta and safety yellow in color. The signs will be conspicuous and obvious from all directions. In the event that the levels exceed 5 mr/hr, then a sign stating "Caution - High Radiation Area", magenta and safety yellow in color will be conspicuously posted.

2. All vehicles transporting or containing radioactive materials will bear a placard on four sides with the proper labelling of the word "RADIOACTIVE" (11" x 11" square). It is clearly understood that this placard will not be displayed if the vehicle is not carrying or storing radioactive materials.

3. All containers carrying, storing or used for transporting radioactive materials will bear a tag with the identification of the radioactive material, and the exposure level (mr/hr) of the material.

IV. SOURCE HANDLING PROCEDURES

A. Only company employees who are licensed radiation handlers and who have been trained in handling sealed sources shall perform or directly supervise operations utilizing a sealed radioactive source.

B. The source assembly will be transported to and from location in full compliance with Department of Transportation regulations (49 CFR). The source assembly will be carried in a transportation container that meets USA DOT 7A specifications and which is fastened to an integral part of the vehicle and located at the furtherest point possible away from the driver or passengers. Shipping papers as outlined in 49 CFR Subpart C - Parts 172.200 thru 172.204, will be carried in the cab of the vehicle.

C. Prior to leaving the facility for the job site, the source will be logged out on the Source Utilization Log (Ref: Figure #2) and a survey made using a low level survey meter approximately 6 inches from the source container. This log will be kept in the radiation files for review by regulatory agents.

D. At no time will a source be handled by hand. All loading or unloading will be done with the aid of a source handling tool or other approved handling tool.

E. All employees involved in operations using a source will wear a personnel monitoring device (TLD badge). A certified calibrated low level survey meter will be available during all operations using a source.

F. At the well location, and prior to beginning operations utilizing the source, operator will complete "Before" portion of the Job Site Survey. (Ref: Figure #6)

G. A restricted area of not less than 30 feet around the work area will be established and marked with signs, barrier rope, or other designation. Direct surveillance will be maintained by the supervisor or designated employee during all source handling procedures to protect against unauthorized and/or unnecessary entry into the restricted area.

H. Using the remote handling tool, the source assembly is removed from the transport container. The source assembly is attached to the logging tool and placed inside the well.

I. When logging procedures have been completed, the tool is returned to the surface, the source shield is replaced, and the source assembly is removed and placed back into the transport container. A vehicle survey is taken to check for contamination and proper transport index (mr/hr at 1 yard). "After" portion of the Job Site Survey is completed before leaving location to show there is no ground contamination.

J. Upon return to facility, source assembly will be surveyed and logged in on the Source Utilization Log (See C above). Source assembly will then be returned to the storage bunker using the source handling tool, and storage bunker locked.

460611

V. LOST SOURCE PROCEDURES (Ref: Figure 3)

A. Prior to performing well logging operations using a sealed source, a written agreement must be executed between licensee and the well owner/operator, stating that within thirty (30) days after a well logging source has been classified as irretrievable, (1) the source will be immobilized and sealed in place with a cement plug, (2) a whipstock or other deflection device will be set well above the cement plug unless the source is not accessible to any subsequent drilling operations, and (3) a permanent identification plaque will be mounted at the surface of the well. (See Section C for specifics).

B. In the event a tool containing a sealed source of radioactive material is stuck in an oil or gas well, the following procedures should be followed to insure maximum safety:

1. Remain in contact with the well operator and offer advice and recommendations regarding safe fishing (retrieval) procedures and make the well operator aware of the possibility that fishing procedures might damage the source capsule.

2. During the retrieval operations, the logging supervisor will monitor for radiation at the surface, using a gamma logging tool near the pipe for fluids circulating from the hole, or using a low level beta/gamma survey meter with a thin window beta probe, or a scintillation probe with high enough energy resolution to accommodate the pipe thickness.

3. Upon retrieval of the source, if no radioactive contamination is detected, logger will remove the source housing assembly from the logging tool and physically check it for any damage such as abrasions brought about by metal to metal contact or any disfigurement brought about by pressure.

4. Should any radioactive contamination be detected during retrieval or if the source appears to be damaged, we will immediately notify the State or Federal regulatory agency governing radiations. (Emergency telephone number on cover page of this manual.)

5. If there is no evidence of radioactive contamination or physical damage, the source will be returned to a licensed storage facility for our company where it will be leak/wipe tested and the wipe sent for immediate analysis. The source will be kept in the storage container out of service pending receipt of the analysis results.

C. If it becomes apparent that the source cannot be retrieved and will have to be abandoned downhole, we will notify the State or Federal regulatory agency having jurisdiction over radiation and any regulatory agency governing the drilling of oil and gas wells. Following are procedures to follow for safe abandonment of a source downhole:

1. After notifying the regulatory agencies, the logging supervisor should determine steps to be taken to abandon the source in such a way as to protect persons and property now and in the future, considering what the well operator wishes and can reasonably do, and then present this proposal to the regulatory agencies for final approval or further recommendations.

2. A source left below a producing zone presents little difficulty. In most cases the normal cementing of the production string of casing or tubing will isolate the source. If the well is to be produced from open hole completion, cement should be spotted around and/or above it to prevent the movement of fluids past the capsule and eventual destruction of the capsule through abrasion.

3. In questionable cases the life of the capsule and the solubility of radioactive material might influence the acceptance of the proposal. (The source capsules have an estimated life of 500 years in undisturbed salt water. The solubility of the radioactive materials is in the order of one part per billion per week.)

4. Production of gas, water or oil past a source should be prohibited unless the capsule is protected from abrasion. Casing or tubing should be adequate. The spotting of cement, if practical and feasible, adds to the protection. Care should be taken in setting casing past the location of the tool to avoid dislodging it. A gamma-ray survey run after the casing is below the zone will give assurance that the tool and source will not be encountered and damaged at a lower level.

5. In the event a source is left in a producing zone, it should be cemented in place if possible. Extreme caution should be used to avoid re-entering the original hole and damaging the source container. Normally, the source is at or near the bottom of the tool. If there were sufficient clearance to place cement around the source, the tool would, in most cases, be retrievable. However, the drilling mud would probably harden in a short time to prevent appreciable flow of fluids by the source. In addition, the separation between the new and old holes would reduce the rate of flow at the tool to a very small figure. It is recommended that the new and old holes be separated by at least 15 feet to preclude any possibility of damage to the source by perforating.

6. Upon abandonment of a radioactive source in an oil or gas well, licensee shall provide a permanent plaque for posting the well or well bore. It shall be constructed of long-lasting material such as stainless steel, brass, bronze, or monel and contain the following information engraved on its face:

   a. The word "CAUTION" in large letters.

   b. The radiation symbol (color not required).

   c. The date of abandonment.

   d. The name of the well operator or well owner.

   e. The well name and well identification number(s) or other designation.

   f. The sealed source(s) by radionuclide and quantity of activity.

   g. The source depth and the plug back depth (depth to the top of the plug).

h. An appropriate warning, depending on the specific circumstances of each abandonment, such as (1) "DO NOT DRILL BELOW PLUG BACK DEPTH", (2) "DO NOT ENLARGE CASING", (3) "DO NOT RE-ENTER HOLE", followed by --- BEFORE CONTACTING (whichever is appropriate) THE U.S. NUCLEAR REGULATORY COMMISSION //or// THE STATE BUREAU OF RADIATION CONTROL.

7. A written report must be filed with the Regional Office of the NRC or the Agreement State Bureau of Radiation Control within 30 days of abandonment, giving description of attempts to recover the source and results of retrieval attempts; steps taken to isolate and protect the source; all pertinent well information; and information contained on the permanent identification plaque. A copy of this report should also be furnished to the State agency issuing permits for or controlling the drilling of oil and gas wells.

VI. EMERGENCY PROCEDURES

A. Vehicle Wreck - In the event of an accident while transporting radioactive materials, the following procedures should be followed:

1. Do not leave the area unattended by qualified personnel.
2. Notify the investigating officer.
3. Notify the Radiation Safety Officer.
4. Survey the area and close off any area where the level exceeds 2 mr/hr.
5. Decontaminate the contaminated area (if any).
6. The RSO will notify the proper regulatory agency.

B. Fire and Other Emergencies

1. Notify all personnel in the area immediately.
2. Attempt to put out all fires if a radiation hazard is not immediately present.
3. Notify the fire department.
4. Notify the Radiation Safety Officer.
5. The RSO will set up restrictions governing the fire fighting and other emergency activities.
6. Following the emergency, monitor the area and ascertain the emergency devices necessary for safe decontamination.
7. Decontaminate.
8. The Radiation Safety Officer will have to approve the area before work can resume.
9. Monitor all persons involved in combating the emergency.
10. Prepare a complete history of the accident and report to the Radiation Safety Officer who will in turn report it to the proper State or Federal regulatory agency.

C. Leaking Source

1. If a source is leaking, which the logging tool would indicate, shut the operation down.

2. Notify contractor and immediately call Radiation Safety Officer for instructions.

3. Set up control procedures for keeping personnel out of the immediate area until instructions are received from the Radiation Safety Officer.

D. Lost Source Downhole(See Section V - Lost Source Procedures).

E. Theft or Loss of Radiation Source

1. Licensee shall report immediately by telephone and confirm promptly by letter to the State or Federal authorities the theft or loss of a source as soon as such theft or loss becomes known to the licensee.

2. Every investigative method should be taken to recover said source.

VII. SOURCE MAINTENANCE AND DISPOSAL PROCEDURES

A. Every radioactive source must be accounted for. Licensee must have records of receipt and disposal and maintain a current source inventory. A source cannot be sold or transferred to anyone who does not have in his possession a current radioactive material license authorizing possession of that particular source (manufacturer and model and curie quantity).

B. Under no circumstances will any employee of licensee remove a source from a source holder or assembly.

C. Any maintenance or service operations which require direct hand contact with the source assembly, such as cleaning or "O" ring exchange will be performed as follows:

1. Since the source assembly is threaded, a hand tool with the appropriate thread, no less than 24" in length, will be made and screwed into the source assembly. The hand tool then will be secured in a table mounted vice. Note: If there is thread damage, the source will be sent back to the manufacturer for repair or replacement.

2. The "O" rings will be cut off with a razor knife. The source assembly will be cleaned with a long nosed solvent spray apparatus, which can be purchased at any automotive supply.

3. Upon completion of the cleaning, a piece of PVC pipe, 18" in length and of the appropriate diameter to fit over the source assembly, will be used to transfer greased "O" rings to the two grooves that have been cleaned. The PVC pipe will be placed over the source assembly with only the "O" ring groove exposed. A modified round wood stick with a flat end will push the "O" ring off of the PVC pipe into the "O" ring groove. Repeat procedure for second "O" ring.

4. Upon completion of replacement of the "O" rings, the handling tool used for normal operations will be used to unscrew the source assembly from the support holding tool while still in the vice and replaced to its assigned transportation container/shield.

D. Sealed sources will be returned to the Manufacturer for disposal, in compliance with transportation regulations previously mentioned in this manual. Receipt from manufacturer must be placed in the radiation files as a record of disposal.

RADIOACTIVE SOURCE INVENTORY AND INSPECTION

ISOTOPE	ACTIVITY	SERIAL NO.	LOCATION	LEAK TEST DATE	PHYSICAL INSPECTION*			
					SOURCE HOLDER	TRANSPORT CONTAINER	HANDLING TOOLS	LOGGING TOOLS

* Visual inspection of physical condition and proper labeling.

BY _____

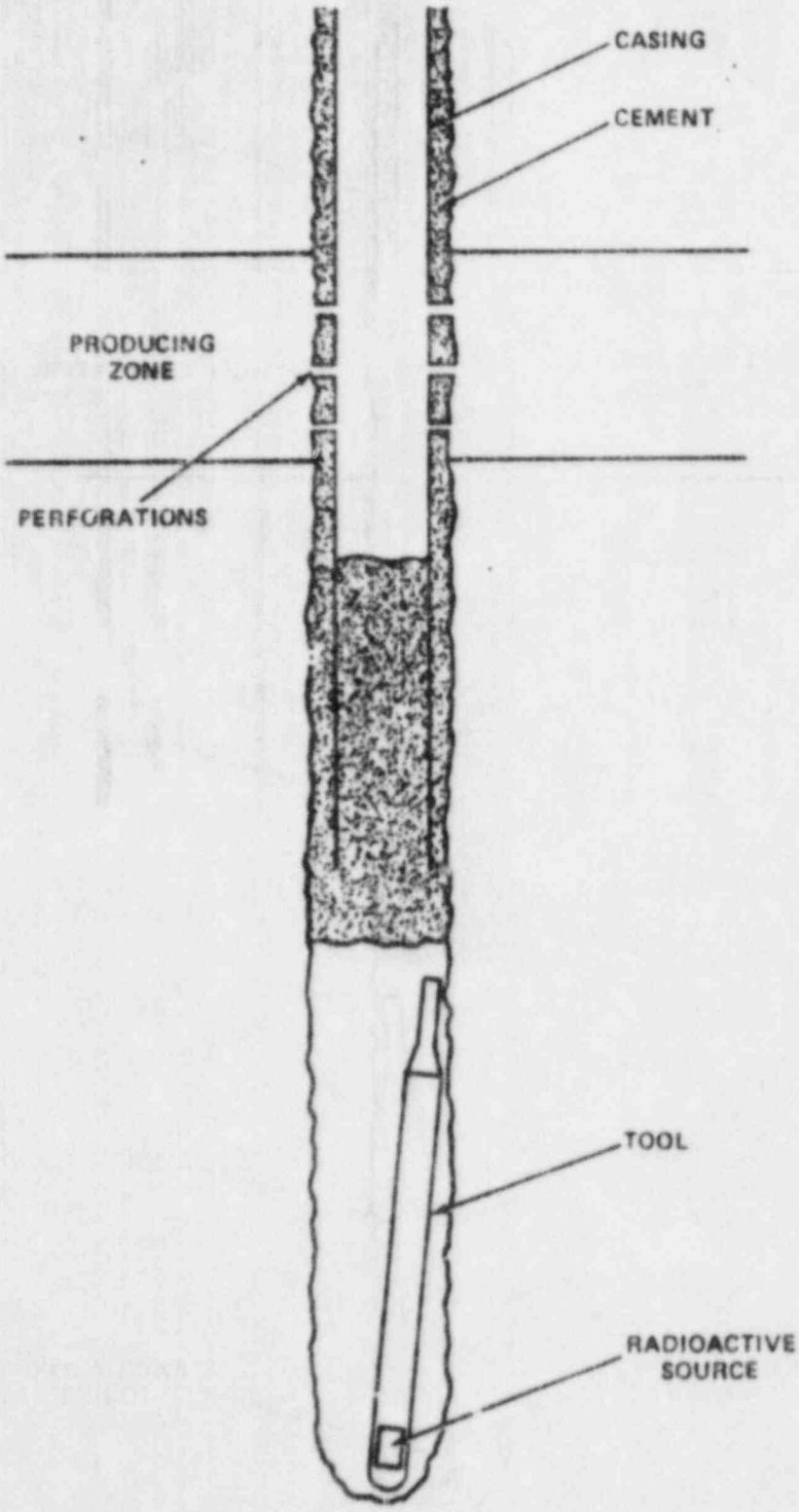
DATE _____

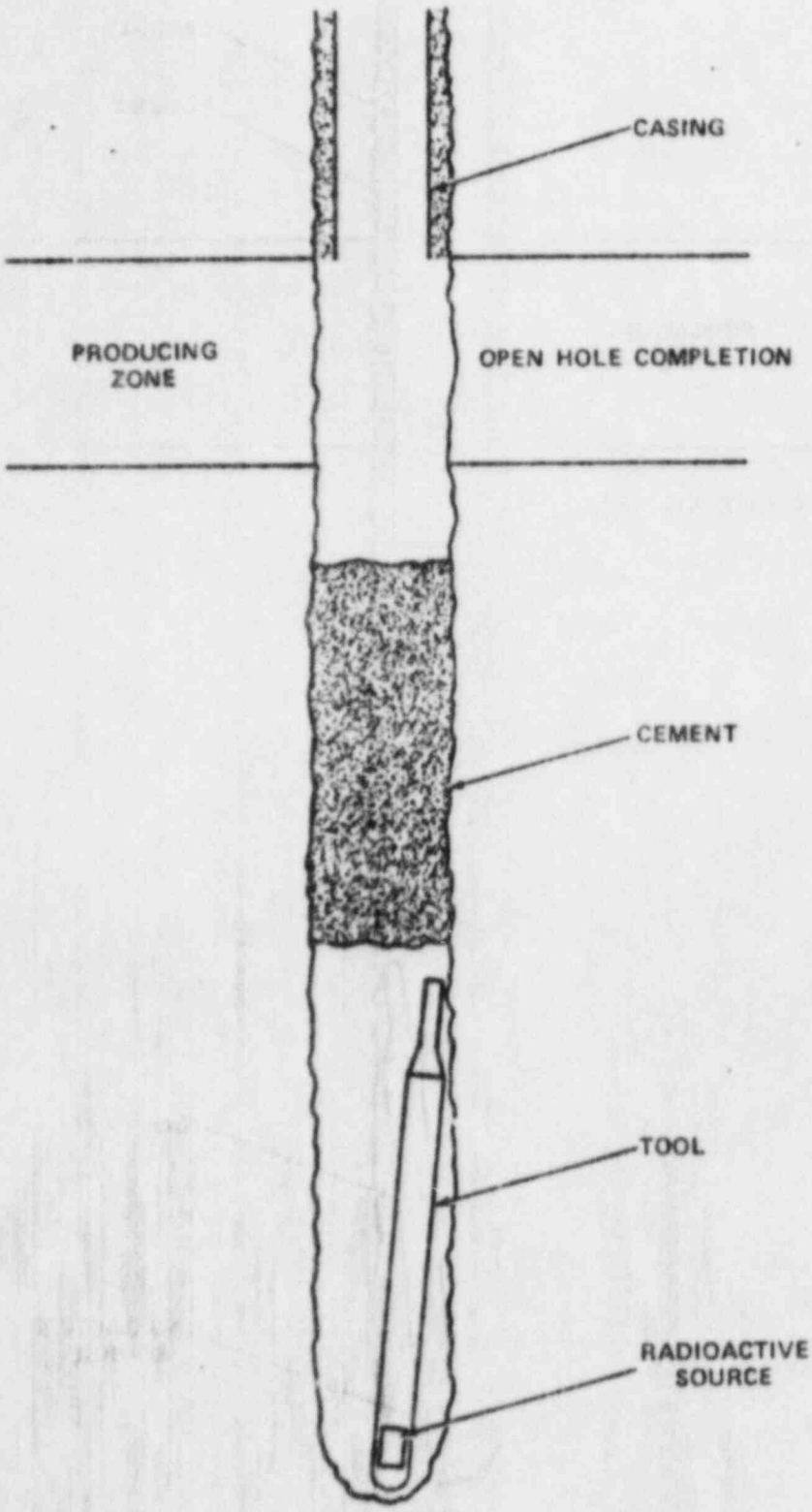
FIGure #1

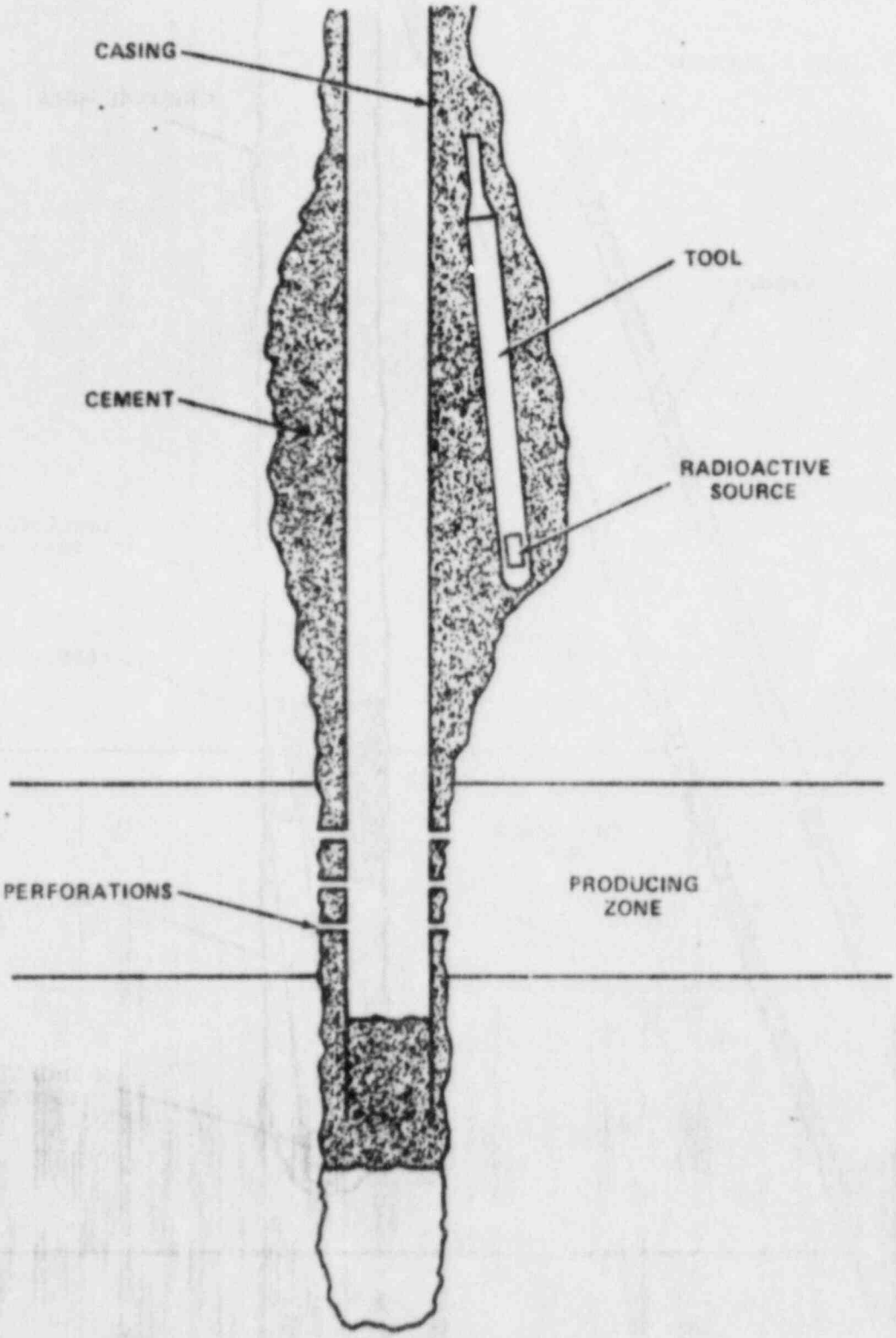
Figure # 2

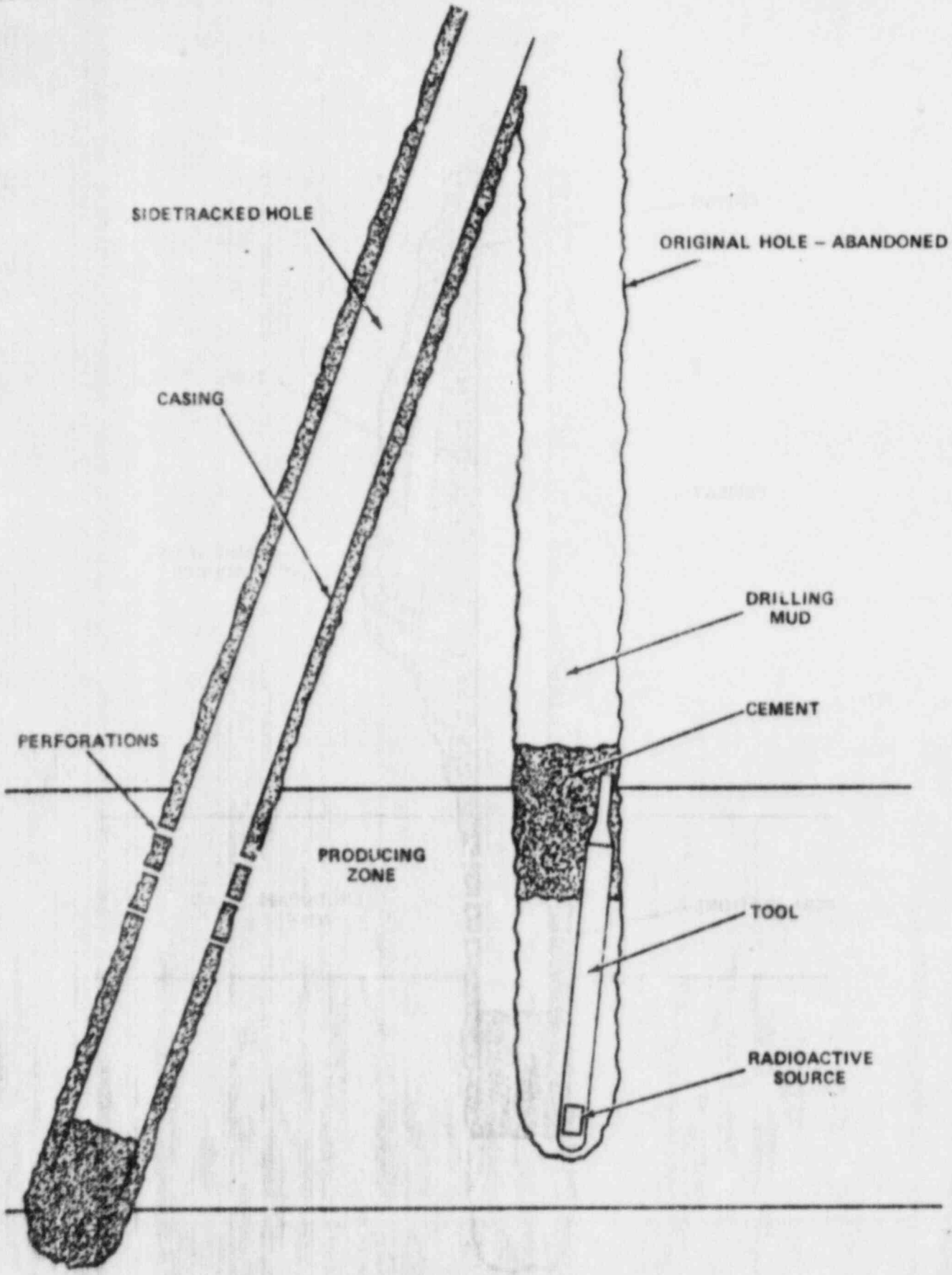
SOURCE UTILIZATION LOG

SOURCE NUMBER	DATE REMOVED	MR/HR (6 in.)	LOCATION OF USE	DATE RETURNED	MR/HR (6 in.)	NAME (Authorized User Only)


CASING
CEMENT
PRODUCING ZONE
PERFORATIONS
TOOL
RADIOACTIVE SOURCE


CASING
PRODUCING ZONE
OPEN HOLE COMPLETION
CEMENT
TOOL
RADIOACTIVE SOURCE


CASING
TOOL
CEMENT
RADIOACTIVE SOURCE
PERFORATIONS
PRODUCING ZONE


SIDETRACKED HOLE
ORIGINAL HOLE – ABANDONED
CASING
DRILLING MUD
CEMENT
PERFORATIONS
PRODUCING ZONE
TOOL
RADIOACTIVE SOURCE

Railroad Tracks

MONTHLY FACILITY SURVEY

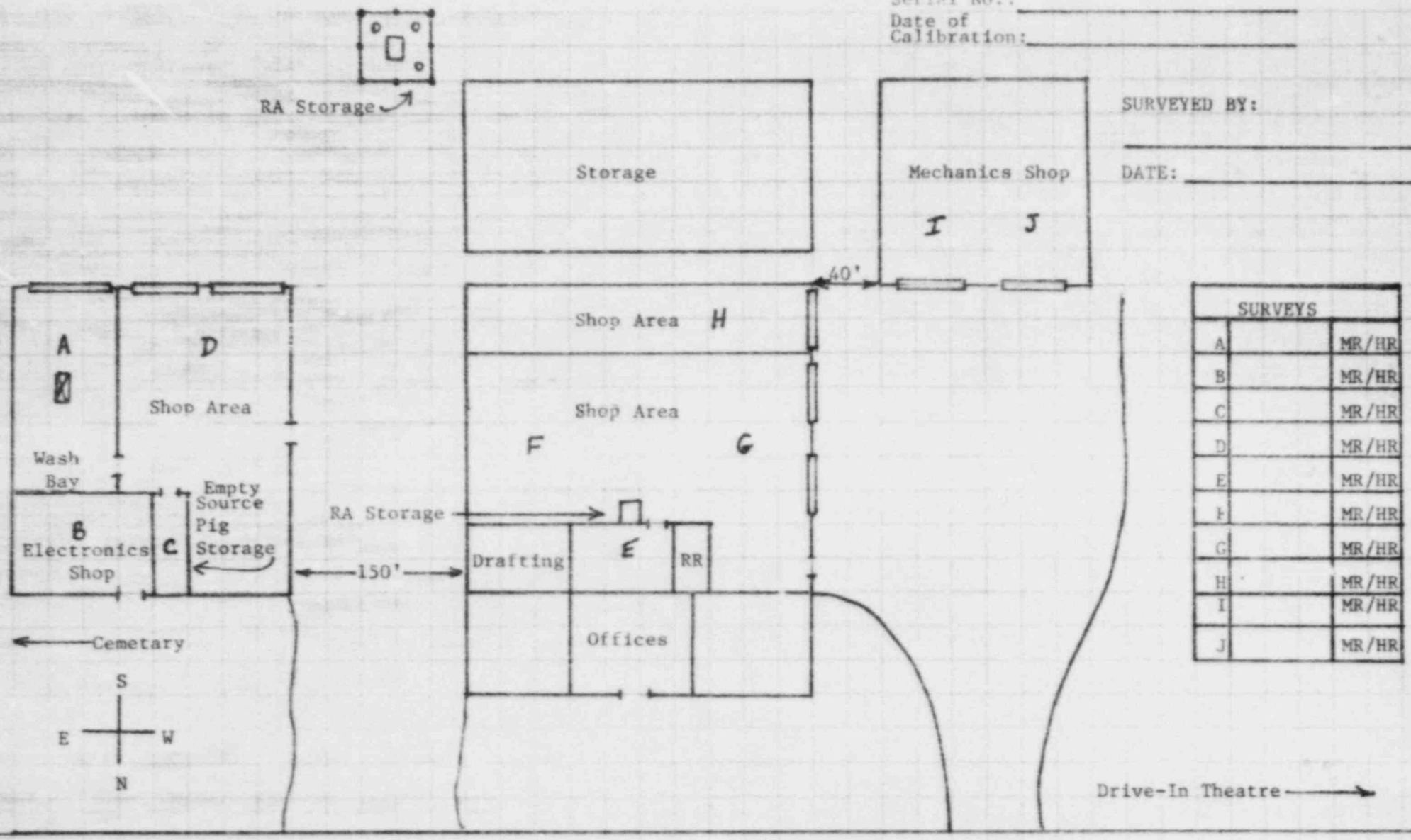
SURVEY METER INFO:

Make: _____

Model: _____

Serial No.: _____

Date of Calibration: _____



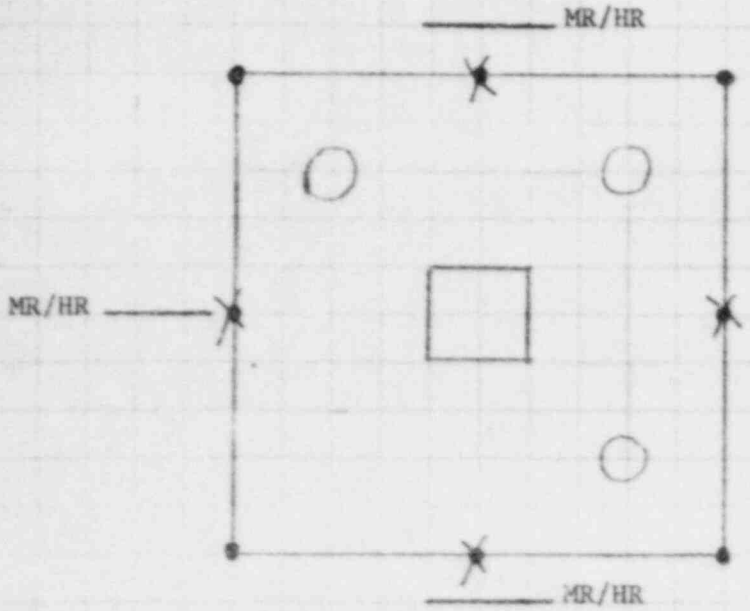
EAST HIGHWAY 16

To Downtown Upton

Not Drawn to Scale

Figure #4

OUTDOOR UNDERGROUND STORAGE



10'x10' fenced cement pad. Three source storage pits approx. 3½" casing set eight feet deep. 2'x2' steel box bolted to pad for tracer materials storage.

Pits and box have lockable lids and fence is locked.

X - Denotes RA Warning Signs

SURVEY METER INFO:

Make: _____

Model: _____

Serial No: _____

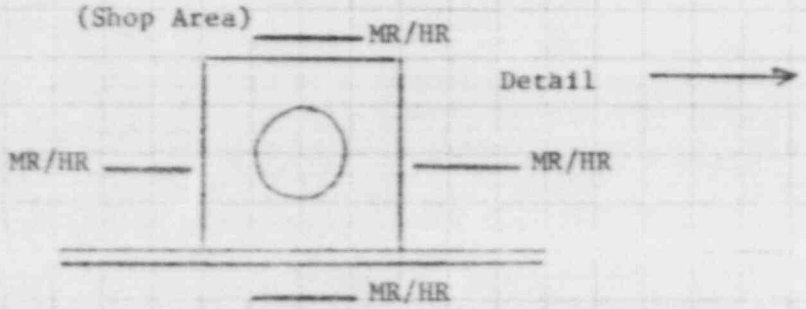
Date of Calibration: _____

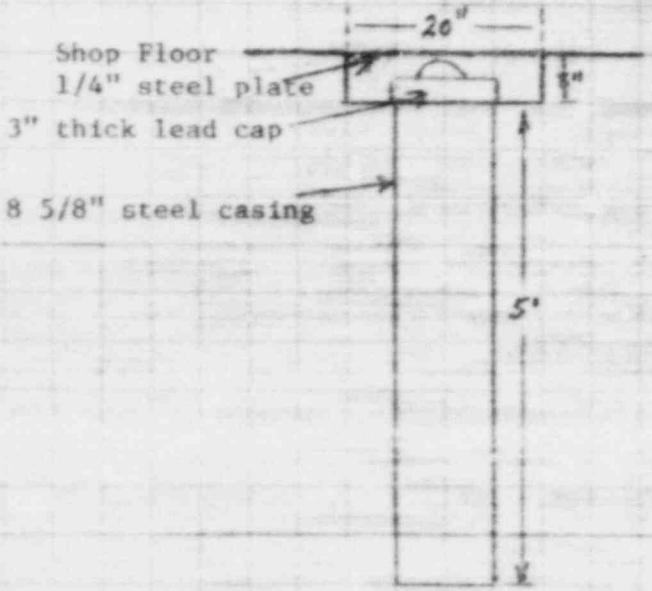
SURVEYED BY:

_____

DATE: _____

INDOOR UNDERGROUND STORAGE





RADIOACTIVE MATERIAL STORAGE BUNKER SURVEYS

Figure #5

Figure #6

SURVEY BEFORE AND AFTER USE OF RADIOACTIVE MATERIALS

DATE _____

WELL IDENTIFICATION: _____
Name Number

LOCATION: Field _____

County _____

State _____

SURVEY METER IDENTIFICATION

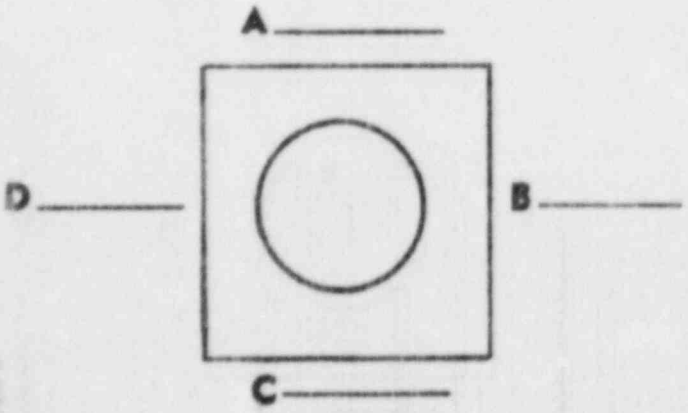
Model Number _____

Manufacturer _____

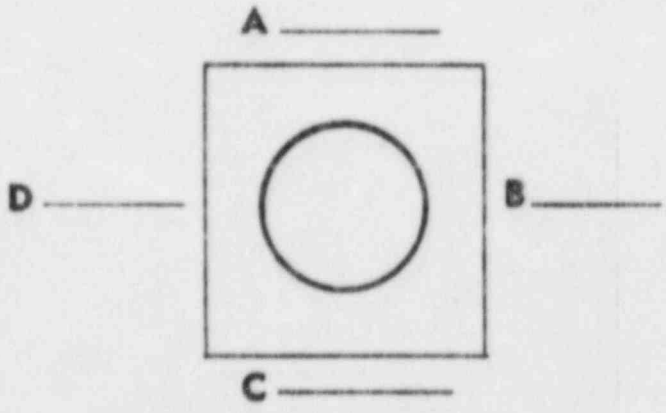
Serial Number _____

DATE OF CALIBRATION _____

BEFORE - MR/HR



AFTER - MR/HR



_____
OPERATOR

MONTHLY VEHICLE SURVEY

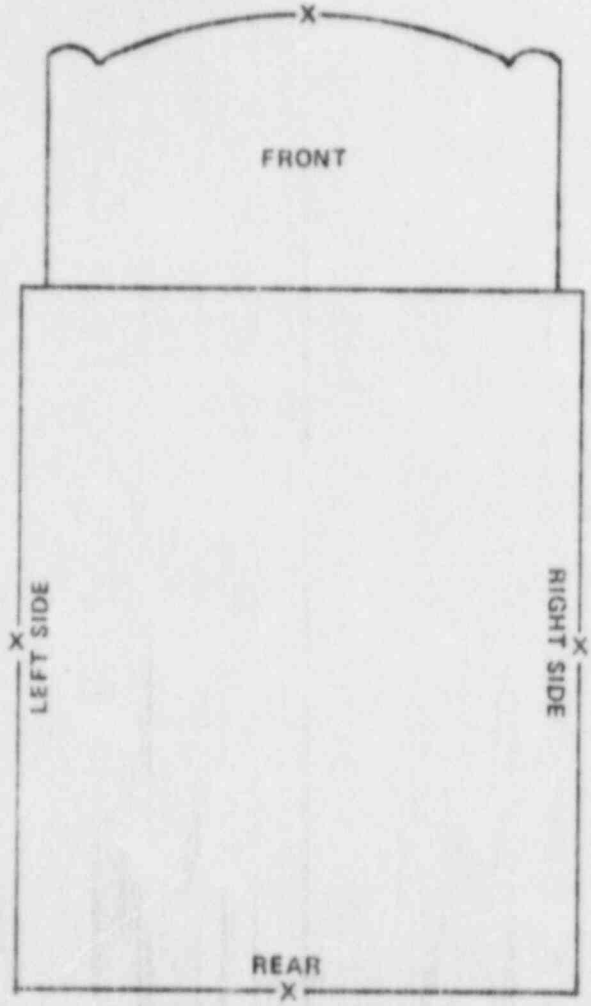
DATE _____

SURVEY METER IDENTIFICATION:

MANUFACTURER _____ SERIAL NO. _____

MODEL NO. _____ DATE OF CALIBRATION: _____

ALL READINGS IN MR/HOUR



SURVEY

FRONT _____ MR/HR

REAR _____ MR/HR

RIGHT SIDE _____ MR/HR

LEFT SIDE _____ MR/HR

X – DENOTES POSTING WITH RADIOACTIVE SIGNS

_____
OPERATOR

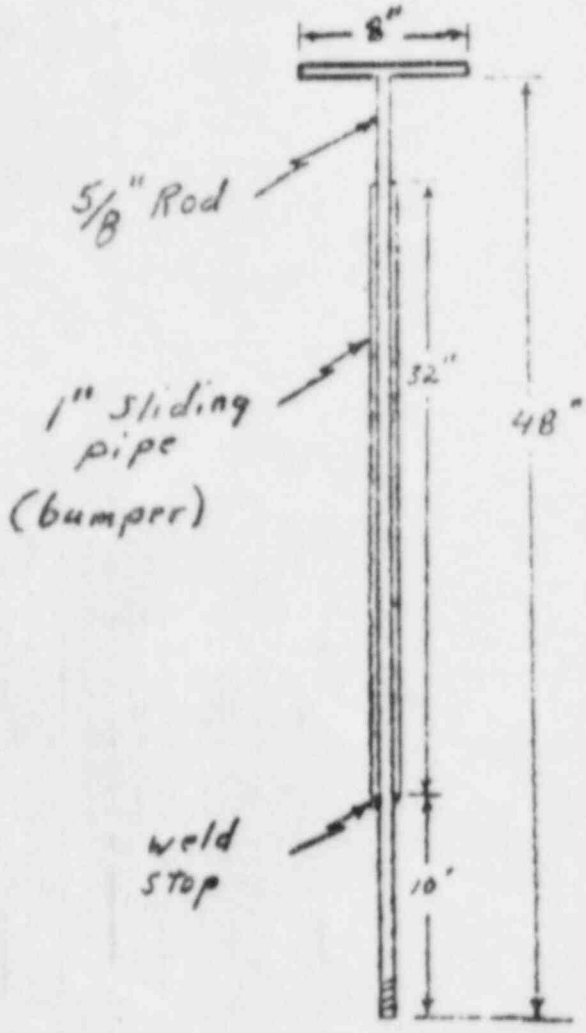
Unit/Truck No. _____

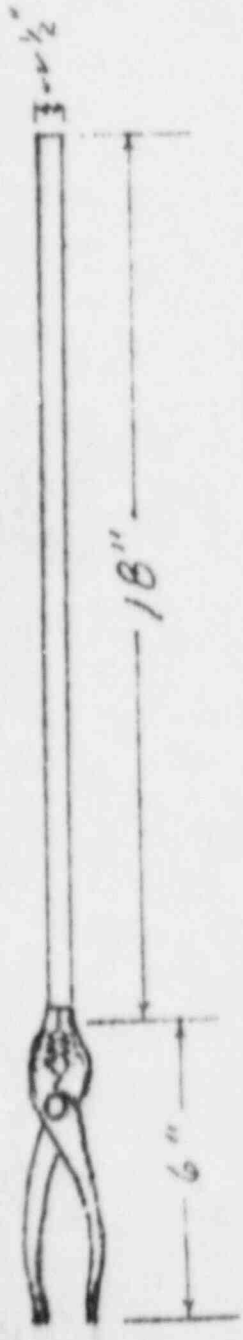
460611

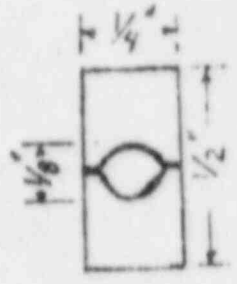
Figure #8

SOURCE HANDLING TOOL

2 Curies Cesium 137





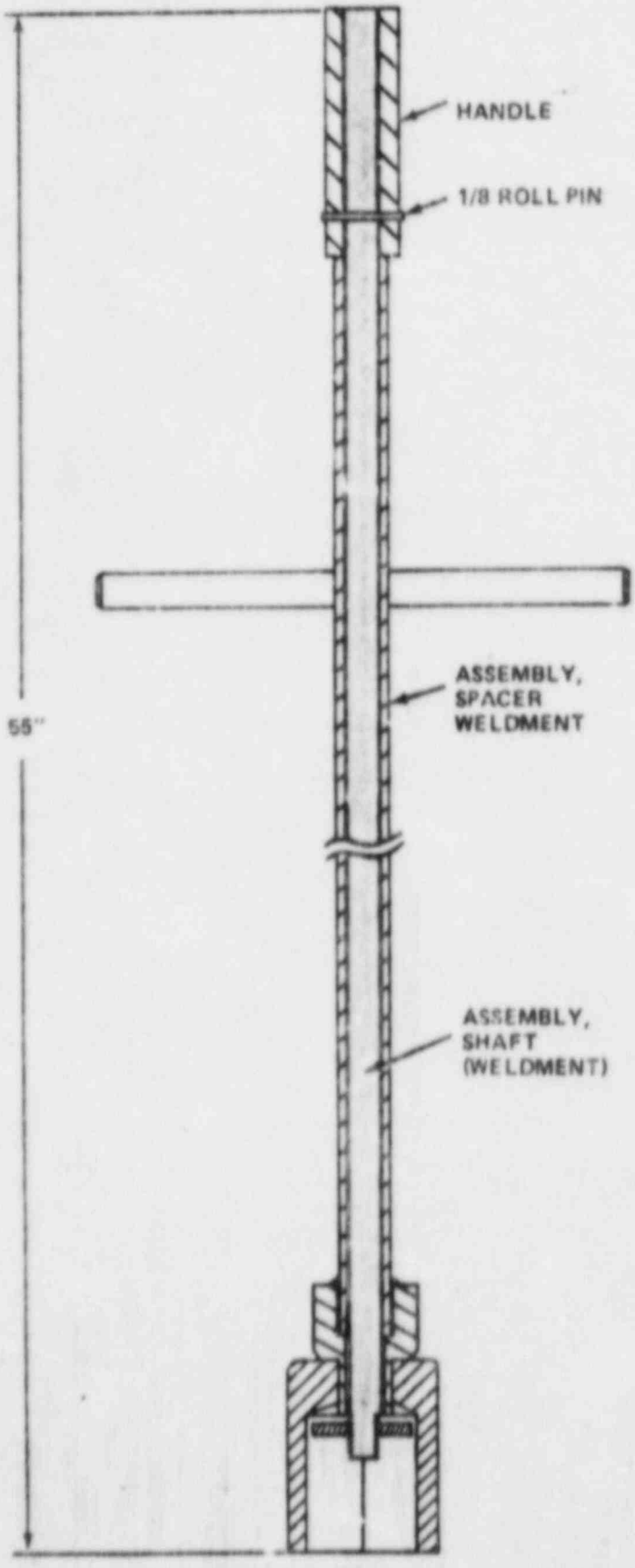


SOURCE HANDLING TOOL

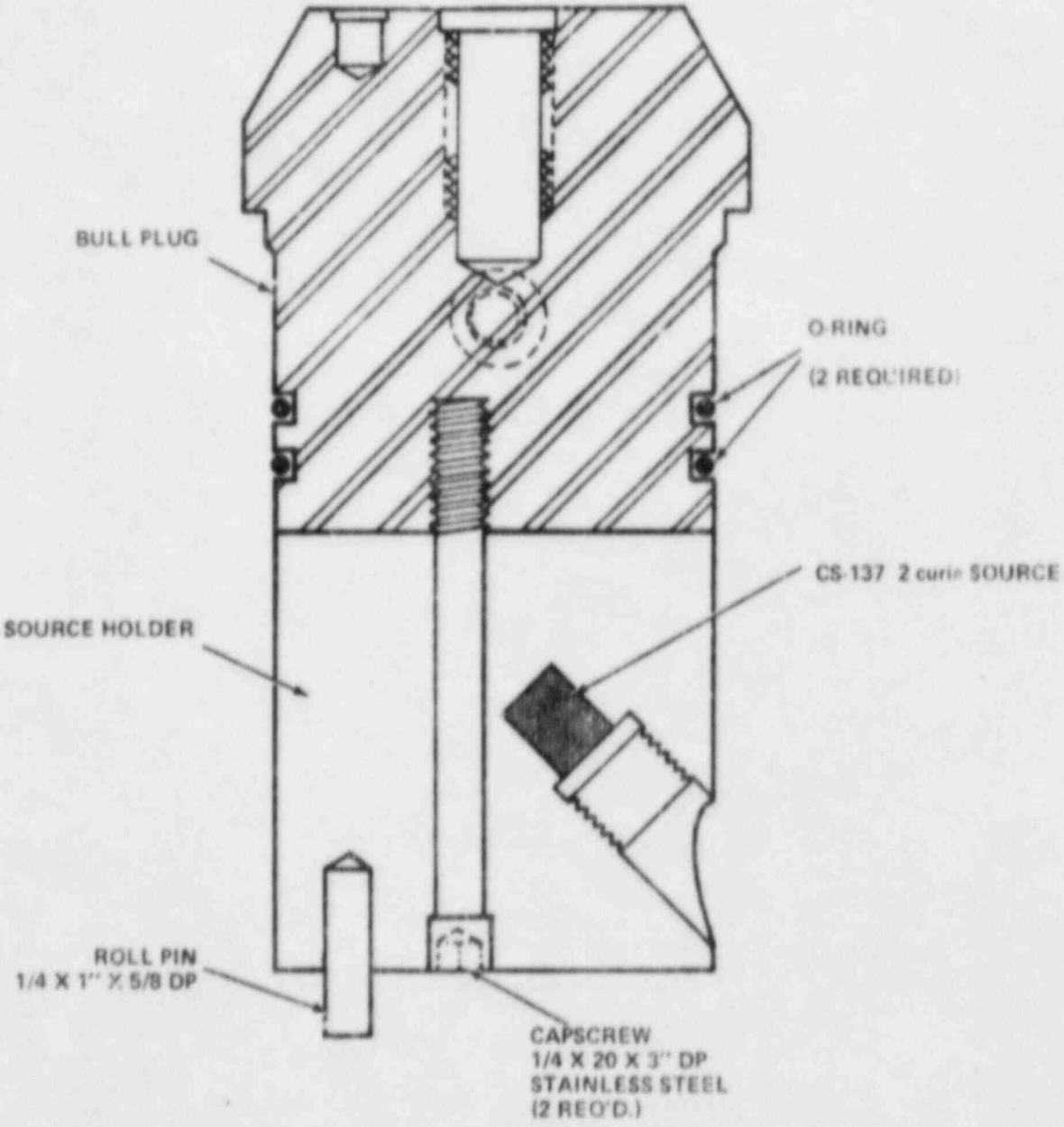
125 Millicuries Cesium 137

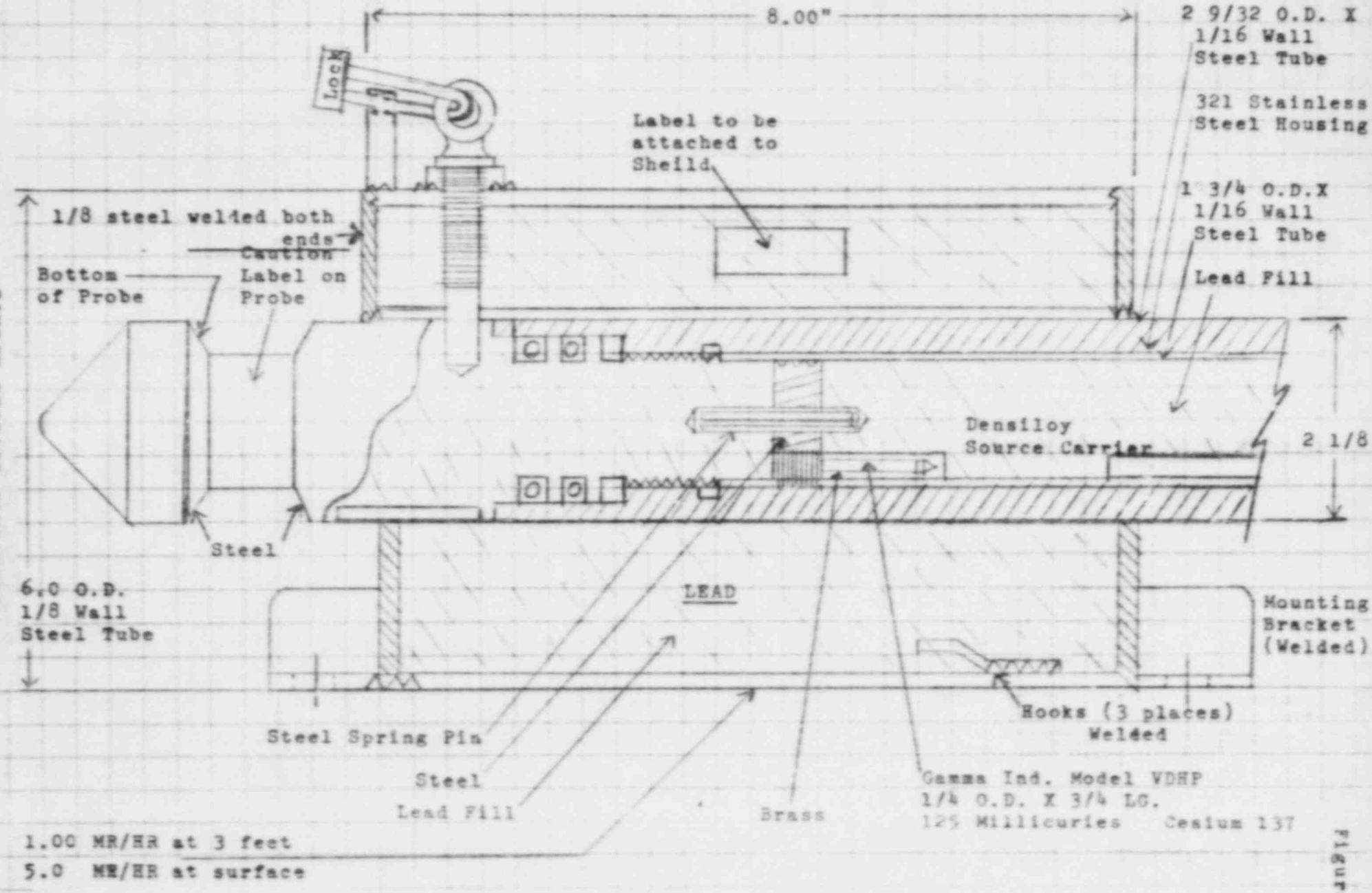
SOURCE LOADING TOOL ASSEMBLY
SOURCE HOLDER – 3 curie AmBe 241

Figure #10



SOURCE HOLDER ASSEMBLY
F/2ci – CS-137

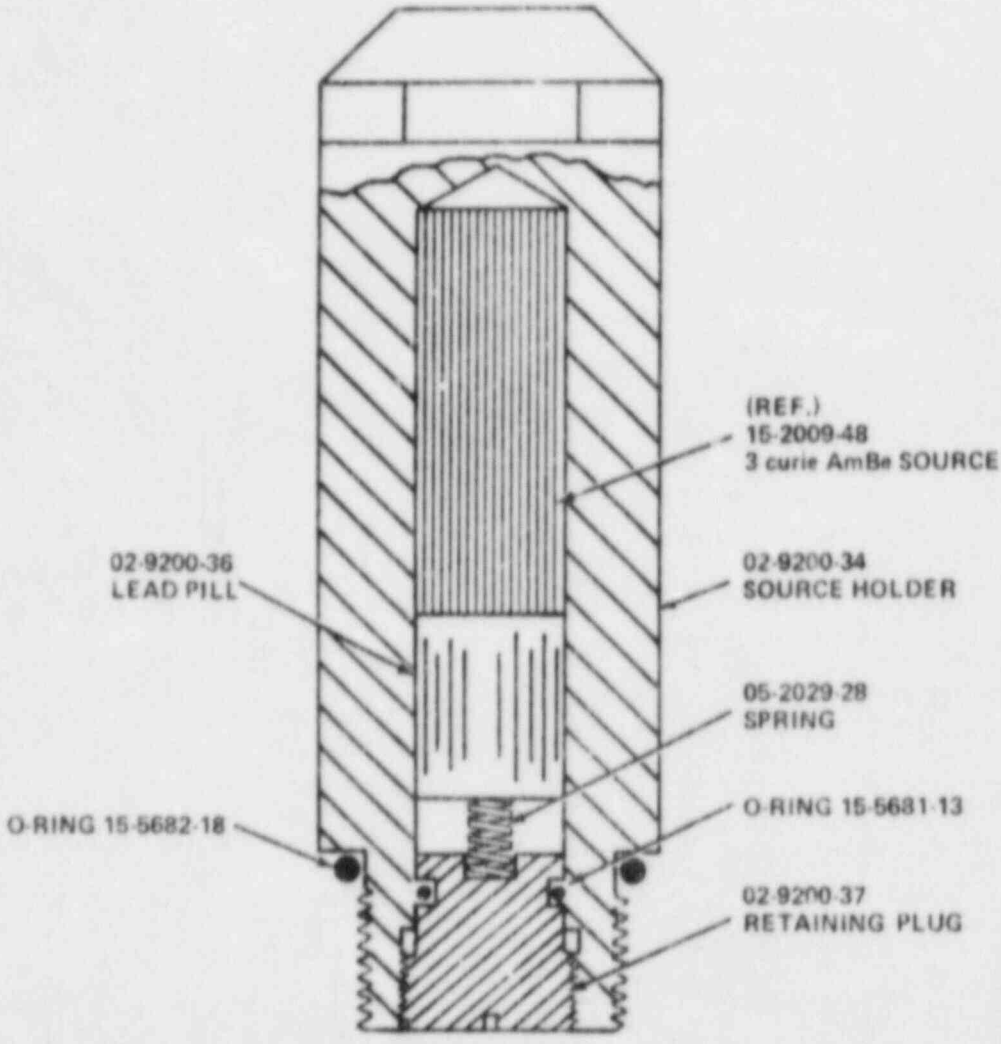




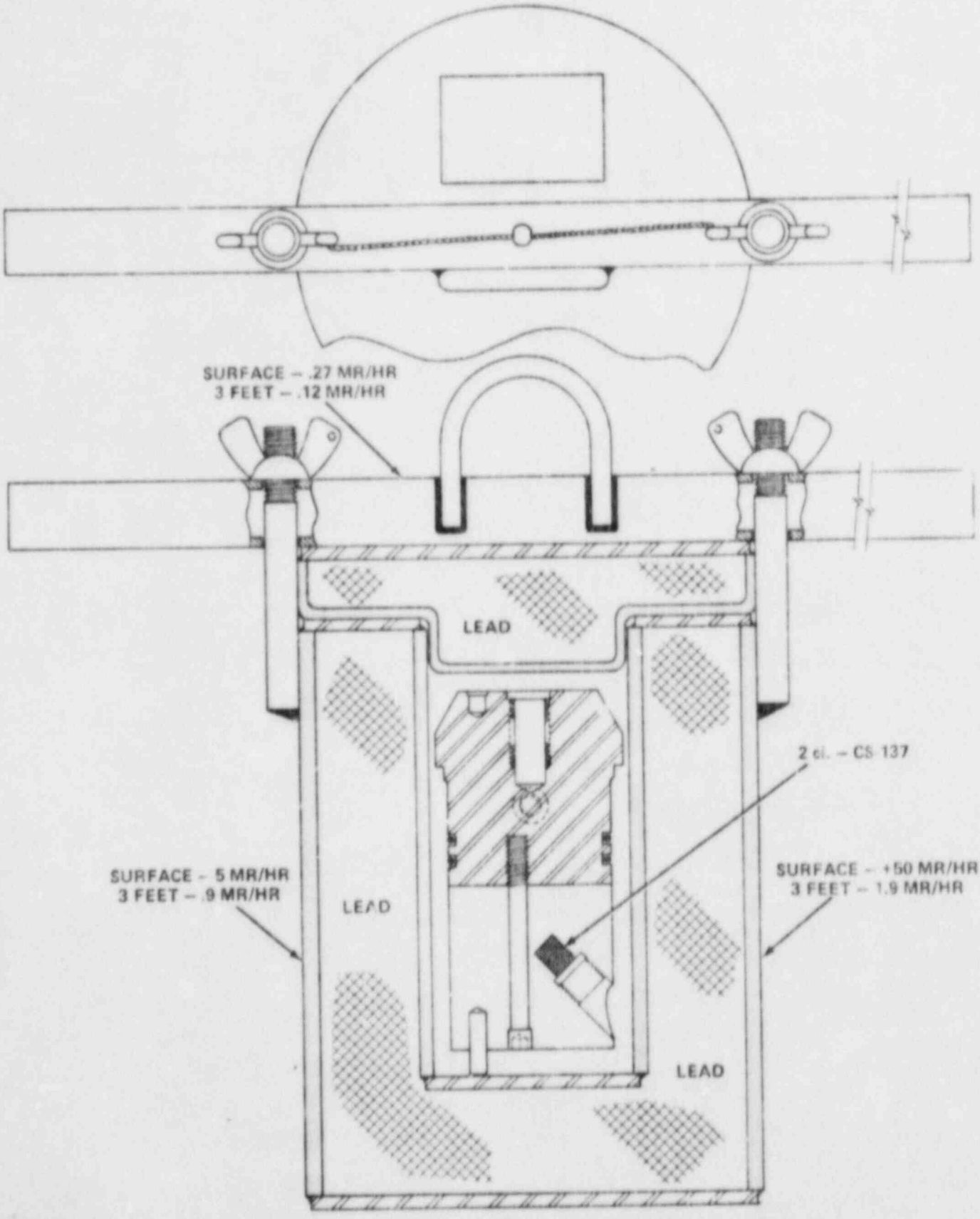
SOURCE STORAGE CONTAINER
COMPROBE, INC. Model 2103 - 125 mCi. Cesium 137

Figure #12

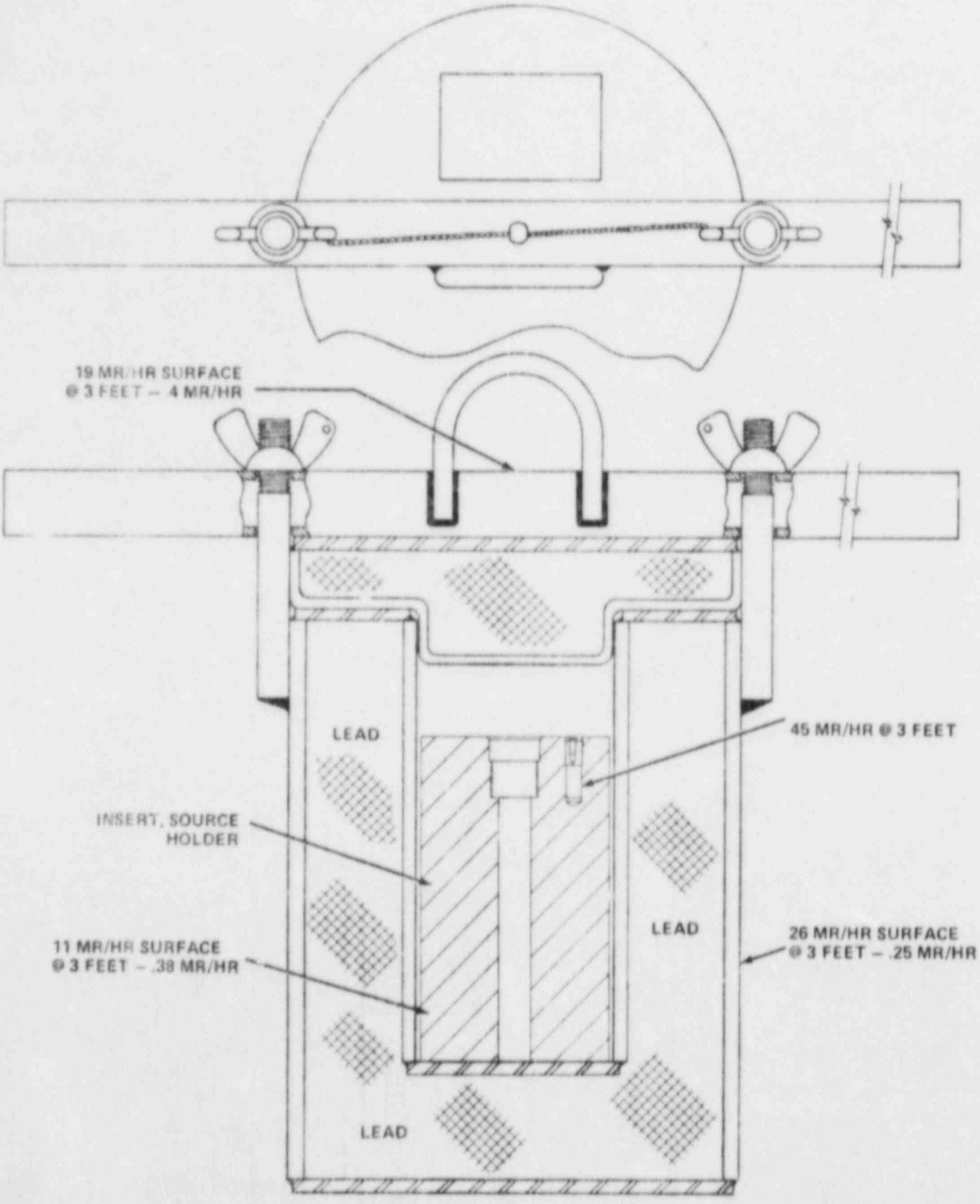
SOURCE HOLDER ASSEMBLY
3 curie AmBe SOURCE
02-9200-18



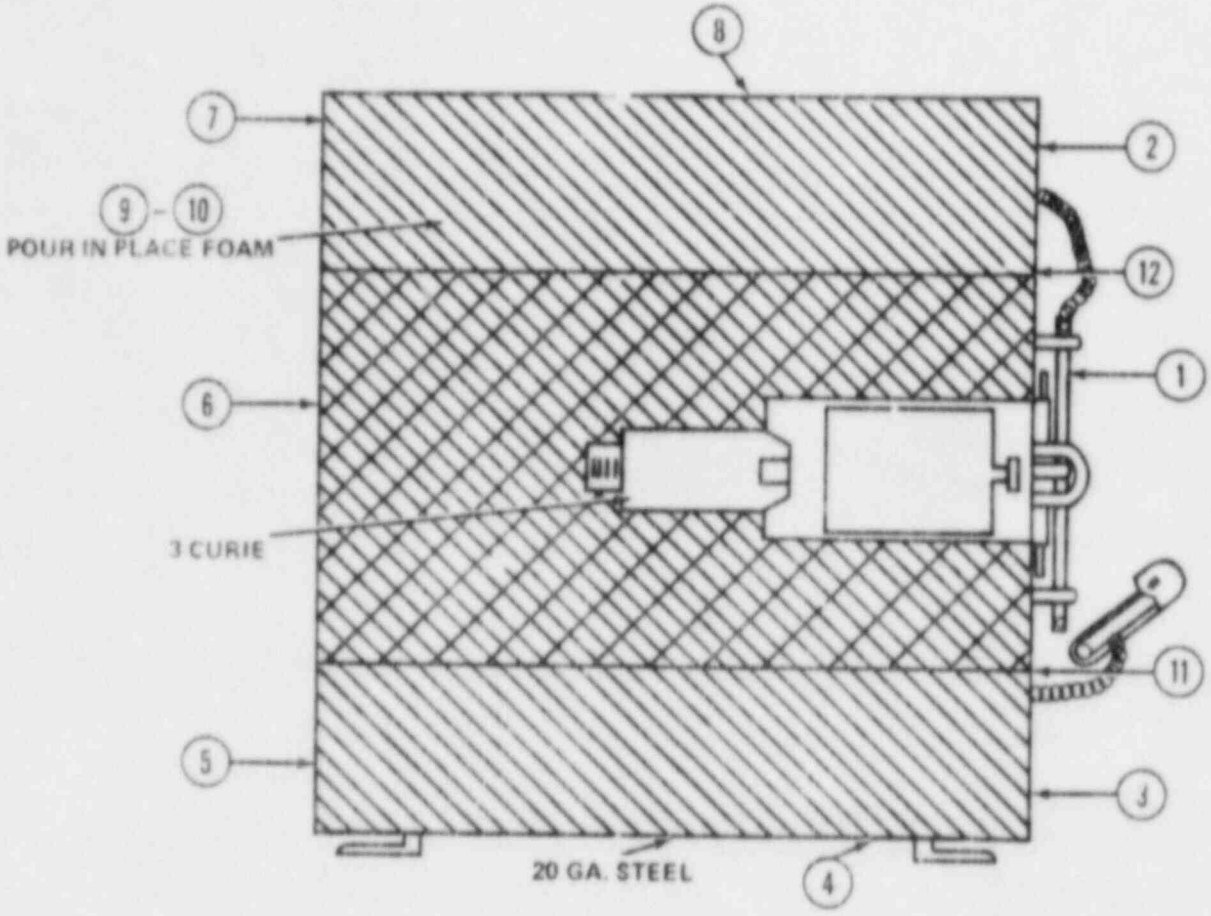
SOURCE STORAGE ASSEMBLY
2 curie – CS-137



SOURCE STORAGE ASSEMBLY
AND SHIELD 125mc – CS-137



3 curie AmBe 241 SHIELD
D.O.T. – 7A



NO.	NEUTRONS	GAMMA
1	40 MR/HR	1.0 MR/HR
2	20 MR/HR	1.0 MR/HR
3	40 MR/HR	1.0 MR/HR
4	48 MR/HR	2.0 MR/HR
5	32 MR/HR	1.2 MR/HR
6	44 MR/HR	1.8 MR/HR
7	32 MR/HR	1.3 MR/HR
8	48 MR/HR	2.0 MR/HR
9	48 MR/HR	2.0 MR/HR
10	48 MR/HR	2.0 MR/HR
11	48 MR/HR	2.0 MR/HR
12	48 MR/HR	1.8 MR/HR

460611